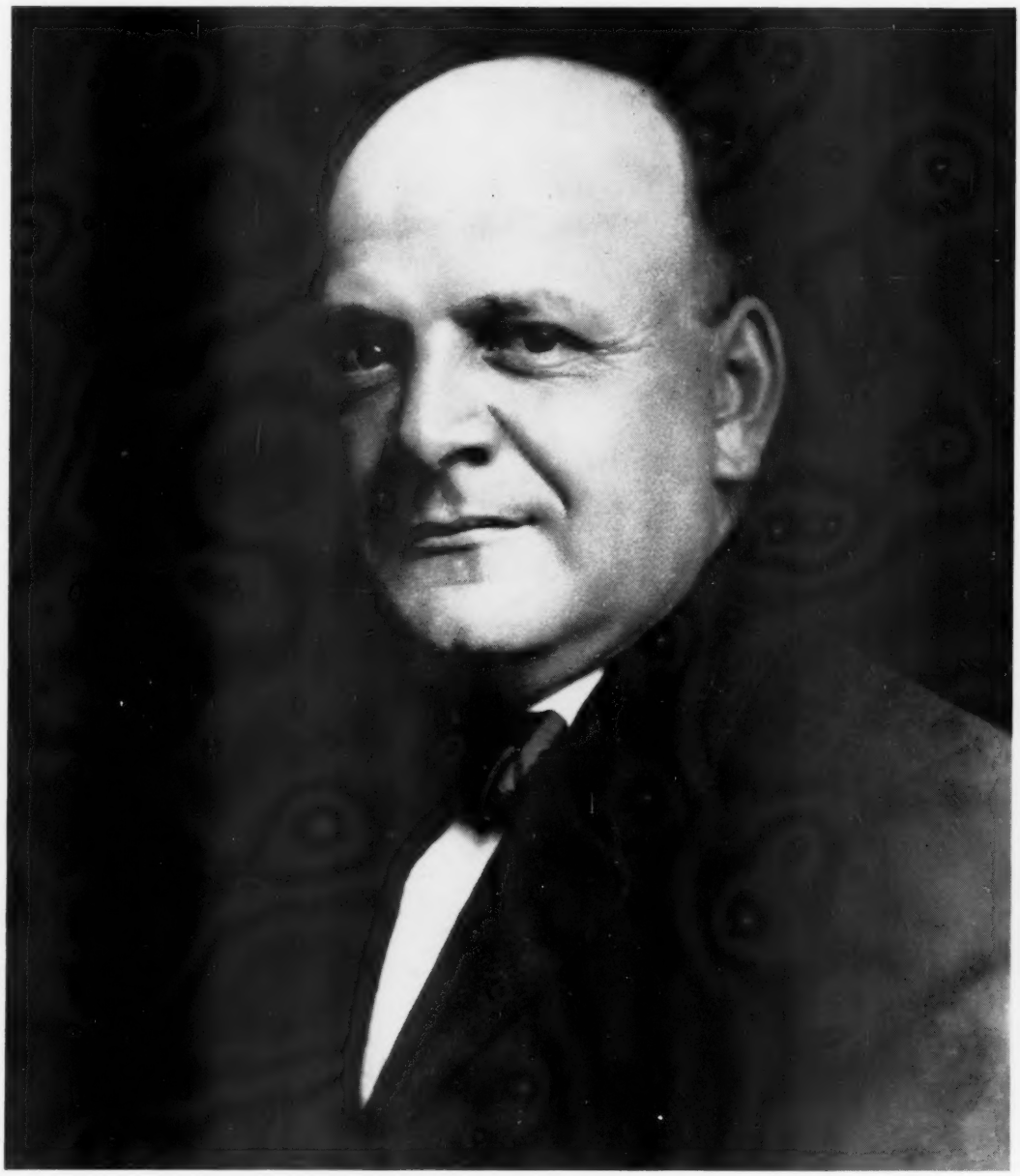
THE BULLETIN

OF THE

AMERICAN CERAMIC SOCIETY

Volume 19 DECEMBER, 1940 Number 12



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For story, see page 478

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THE BULLETIN OF THE AMERICAN CERAMIC SOCIETY

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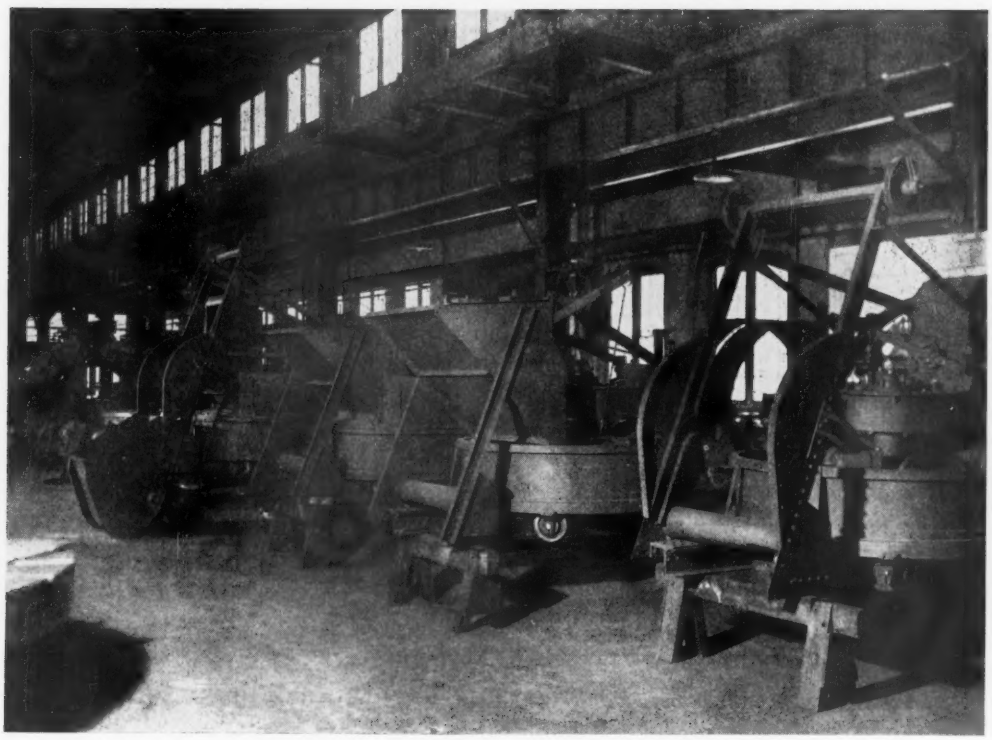

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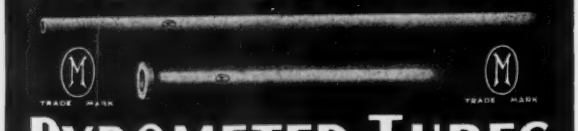

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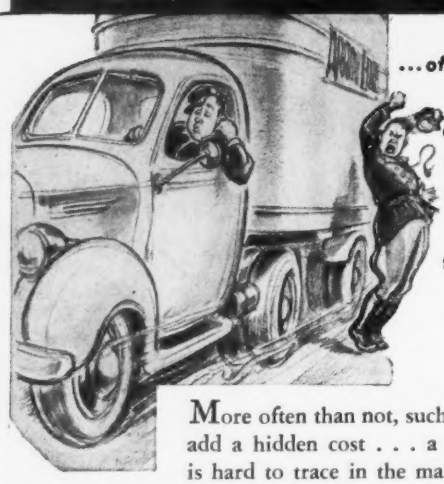

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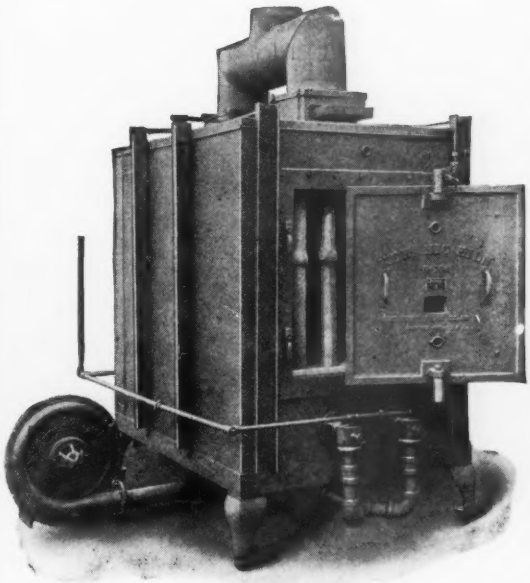

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Fire placed in tank	October 4, 1937
Production started	October 18, 1937
Production off—fires out	February 27, 1939
Fires placed back in tank	March 2, 1939
Production on	March 7, 1939
Production off—fires out	March 11, 1940
Melting end area	504 Square feet

Total days life	884
Operating days	833
Days heating up	17
Idle days	34

Total tons glass produced	65,011
Tons glass produced per operating day	78.0
Sq. ft. melting area per ton glass per operating day	6.46
Average pack	90%
Cause of shut down	Ports
Tons per sq. ft. melting area per life	128.9

Note: When this tank was rebuilt, Corhart* Standard Electrocast was used in breastwalls and ports.

This, you will agree is a rather spectacular record. Yet it has been closely approached by several Corhart tanks in the past, and will unquestionably be exceeded by many such tanks in the future. For the glass industry is moving forward more rapidly today than ever before, and the records of 1940 are unquestionably the commonplace performances of tomorrow. . . .

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A Monthly Publication Devoted to Proceedings of The Society and Promotion of Cooperative Research of Technical, Scientific, and Art Questions

Volume 19 DECEMBER, 1940 Number 12

PAPERS

CHARACTERISTICS OF A VIRGINIA KYANITE*

By J. P. Sawyer, Jr., and J. W. Whittemore

Abstract

The physical and chemical properties of kyanite, mined and processed in Prince Edward County, Virginia, were investigated. A spectrographic examination and a study of the effect of heat treatment were also made. These studies indicate that this mineral is of considerable value to the ceramic industries.

I. Introduction

The mineral kyanite is mined and processed in Prince Edward County, Virginia. The deposit, located on Baker Mountain, is sufficiently large to supply the demands of the ceramic industries. Froth flotation of this ore has consistently yielded a kyanite concentrate containing 93% of pure kyanite. Acid-washing of the kyanite concentrate has produced even purer grades for commercial use. It is the purpose of this paper to direct attention to this mineral and to its physical properties both before and after heat treatment.

II. Mineralogy

Kyanite, like andalusite and sillimaniite, is a member of the sillimanite group of minerals. It has the same chemical composition as andalusite and sillimanite, with the formula $Al_2O_3 \cdot SiO_2$, but it differs from them in that it crystallizes in the triclinic system rather than in the orthorhombic system. Its specific gravity is 3.5 to 3.7, as compared to 3.1 to 3.2 for andalusite and to 3.2 to 3.3 for sillimanite.

The kyanite of the Baker Mountain deposit occurs in a quartz schist. This deposit contains massive-type kyanite-quartzite, which occurs abundantly, and also small, needlelike masses of radiating crystals in quartzite. The schist includes small amounts of rutile, hematite, pyrite, and quartz, most of which are eliminated by the concentration process and by magnetic separation. The Virginia kyanite occurs as deep greenish-blue, bladelike crystals, which have a hardness of 4 to 5 parallel to the blade and 6 to 7 across the blade.

III. Properties

(1) Behavior on Heat Treatment

Although Peck[1] found that when pure kyanite is heated to about cone 12 (approximately 1310°C.) it decomposes into mullite ($3Al_2O_3 \cdot 2SiO_2$) and silica (SiO_2), the decomposition of the Virginia kyanite becomes evident when the material is held at cone 14 (1400°C.) for one hour and is complete when held at cone 15 (1435°C.) for one hour. The specimens heated were 1 inch in diameter and 1 inch high. As a result of heating to these temperatures, it becomes white and granular; there is, however, a small percentage of dark particles in the concentrate which is due to the presence of accessory minerals.

During the decomposition range from cones 14 to 15, the kyanite expands rapidly, the increase in volume being shown by the decrease in specific gravity from approximately 3.5 to 2.9.

On decomposition, an interlocking network of tiny crystals of mullite is formed throughout the original crystal of kyanite. When mullite is introduced into a ceramic body by the addition of calcined kyanite, a stronger body will result because of the desirable

* Presented at the Forty-Second Annual Meeting, The American Ceramic Society, Toronto, Canada, April 10, 1940 (Refractories Division). Received April 10, 1940.

[1] A. B. Peck, "Changes in Constitution and Microstructure of Andalusite, Kyanite, and Sillimanite at High Temperatures and Their Significance in Industrial Practice," *Jour. Amer. Ceram. Soc.*, **8** [7] 407–29 (1925).

properties of mullite and its effect on the structure of the fired body. The effect of the mullite is governed by the quantity added to the body.

(2) Chemical Analysis

The chemical analysis† of raw kyanite concentrate from the Baker Mountain deposit is as follows:

	(%)		(%)
Al_2O_3	58.77	K_2O and Na_2O	0.59
SiO_2	37.70	MgO	Trace
Fe_2O_3	1.17	Ignition loss	0.38
TiO_2	1.30		
			99.91

In commercial production, a grade is developed by acid-washing the concentrates and, because of the reduction of the Fe_2O_3 content and several minor quantities of other materials, the quality of the kyanite is improved. The chemical analysis of the acid-washed kyanite is as follows:

	(%)		(%)
Al_2O_3	59.13	K_2O and Na_2O	0.49
SiO_2	38.20	MgO	Trace
Fe_2O_3	0.42	Ignition loss	0.48
TiO_2	1.20		
			99.92

(3) Softening Point

A representative sample of the Virginia kyanite was made into pyrometric cones which were subjected to the P.C.E. test. Based on two trials, the softening point is 36 to 37, expressed in terms of Orton cones.

(4) Spectrographic Examination

A grating spectrograph of the Rowland-mounting type was used in making a spectrographic examination, which revealed the presence of about 0.1% of chromium, silver, and zirconium.

(5) Microscopic Examination

The complete decomposition of kyanite to mullite and silica, as has been stated, is accomplished at cone 15. The effect of the heat treatment may be noted in Fig. 1 and Fig. 2. Figure 1 shows the crystals of raw kyanite with the characteristic bladed or shaftlike structure. The decomposition of the kyanite crystals into mullite and silica is shown in Fig. 2. The larger crystals are those which just pass a 100-mesh sieve.

By adding calcined kyanite to a body, about 87.5 parts of mullite may be introduced for each 100 parts of calcined kyanite. Most of the remainder is silica, which is liberated by the decomposition of the kyanite. This percentage of mullite is based on the percentage of alumina present in the kyanite and on the specific gravity of the resulting compounds. Pure mullite has a specific gravity of 3.03, and the specific gravity of calcined kyanite is approximately 2.92 to 2.96. Assuming that a mean of the specific gravities of tridymite and cristobalite is 2.25 (the amount of each present is not known), the specific gravity of calcined kyanite is approximately 2.93 with as complete a decomposition to mullite as is possible. The rutile and heavy minerals present in the unconverted state tend to alter slightly the foregoing calculations. For this reason, the specific gravity of this calcined kyanite approaches the theoretical value.

(6) Effect of Temperature on Decomposition of Kyanite to Mullite

A series of small cylinders of raw kyanite was made, using dextrine as a binder, and fired through a range of temperatures varying from 2200° to 2600°F. at intervals of 100°F. The final temperature in each case was held for one hour.

A petrographic examination was made of powdered samples which passed a 100-mesh sieve and were retained on a 200-mesh sieve. The samples of kyanite, fired to 2200° and 2300°F., showed no noticeable evidence of decomposition. The samples fired to

FIG. 1.—Raw kyanite, crossed Nicols, tint plate, 144 ×.

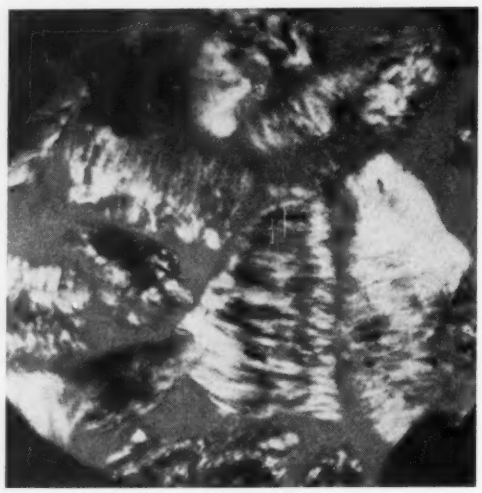

FIG. 2.—Calcined kyanite at 1435°C., crossed Nicols, tint plate, 144 ×.

† Supplied by Phosphate Recovery Corporation.

2400°F. gave evidence of a slight decomposition of the kyanite to mullite on the edges of the smaller grains, which is typical of the manner in which mullite crystals begin to form. They start on the edges and progress toward the center of the grain, as Greig[2] observed in a study of the formation of mullite from kyanite, andalusite, and sillimanite. At 2500°F., the decomposition of kyanite to mullite has proceeded to a high degree. Although there is evidence of some free quartz which has not been appreciably affected by the heat treatment, there is some tridymite and (or) cristobalite. At 2600°F., there is a maximum decomposition of the kyanite grains to mullite and silica, which is present as tridymite, cristobalite, and (or) glass.

These results agree with the work of Harrison,[3] who found, by specific-gravity determinations, that time is not so vital a factor as temperature in governing the rate of decomposition above the initial reaction temperature.

Acknowledgment

The authors of this paper wish to thank Paul S. Dear and H. D. Ussery of Virginia Polytechnic Institute for their aid as well as the Phosphate Recovery Corporation for the chemical analysis used in this paper.

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[2] J. W. Greig, "Formation of Mullite from Kyanite, Andalusite, and Sillimanite," *Jour. Amer. Ceram. Soc.*, **8** [8] 465–83 (1925); discussion, *ibid.*, pp. 483–84.

[3] H. C. Harrison, "Kyanite-Clay Refractories, I," *ibid.*, **9** [5] 257–71 (1926).

RECOVERY OF KYANITE FROM NORTH GEORGIA SCHIST*

By W. B. Boyd

Abstract

North Georgia kyanite schist contains from 4 to 8% of kyanite; about 25% of commercial mica; small quantities of graphite as commercial products; and silica, iron minerals, and slimes as impurities. Kyanite is separated from the gangue by mulling, screening, and jigging; mica is recovered by settling, screening, and tabling; and graphite is recovered by flotation. The process for kyanite separation is described.

I. Introduction

Immediately following the World War, considerable interest was shown in minerals containing a high ratio of alumina, and kyanite offered the advantage of large tonnage deposits.

Deposits of kyanite of commercial grade were located in California near Ogilby,[1] in Virginia near Pamplin,[2] in North Carolina near Burnsville,[3] and in Georgia near Clarkesville.[4] The north Georgia deposits were considered to be the best because an immense tonnage of soft rock could be mined at low cost by open quarry methods and because it disintegrated readily.

Kyanite schists in the Clarkesville area are metamorphic in origin.[5] The exposed portion of the kyanite schist (Fig. 1) is an ellipse with a continuous exposure over a distance of approximately 25 miles and an additional 10 miles of broken exposure in the Tallulah Falls faulted area. The dip is approximately 15 degrees to the center of the ellipse, indicating anticlinal origin, probably owing to the intrusion of the Tallulah Falls quartzite found in the central portion of the area. The kyanite resulting from the weathered schist has accumulated in placer deposits which occur in favorable erosion channels. Some of these deposits also offer a limited source of kyanite crystals from which a considerable tonnage has been recovered.[4]

II. Methods of Recovery Investigated

The wet ball-milling and tabling processes for the concentration of the minerals gave promising results. The minerals could be freed easily, but the separation of the coarse books of mica from the silica and the iron minerals from the kyanite presented difficulties. A portion of the kyanite, furthermore, was easily ground to fine needles; these needles, however, were difficult to separate from the fine mica and slime. The large quantity of sand in the mica tailings reduced the capacity of the tables.

The demand for kyanite of grog size called for a method of disintegration that would free the kyanite crystals from the schist without breaking them. The quartz could be removed by jigging.[6] The ore was

* Presented at the Forty-Second Annual Meeting, The American Ceramic Society, Toronto, Canada, April 9, 1940 (Materials and Equipment Division). Received February 14, 1940.

[1] "California Mineral Production," *Calif. Dept. Natural Resources Bull.*, No. 12 (1935).

[2] A. I. Jonas and J. H. Watkins, "Cyanite in Virginia," *Va. Geol. Surv. Bull.*, No. 38; *Eng. Mining Jour.*, **134** [6] 237 (1933); *Ceram. Abs.*, **13** [1] 23 (1934).

[3] V. L. Mattson, "Kyanite Operations of Celo Mines, Inc.," *Bull. Amer. Ceram. Soc.*, **15** [9] 313–14 (1936).

[4] R. W. Smith, "Kyanite Industry of Georgia," *Amer. Inst. Mining Met. Engrs. Tech. Pub.*, No. 742, 11 pp. (1936); *Ceram. Abs.*, **16** [6] 187 (1937).

[5] L. M. Prindle, *et al.*, "Kyanite and Vermiculite Deposits of Georgia," *Geol. Surv. Ga. Bull.*, No. 46, 50 pp. (1934); *Ceram. Abs.*, **14** [7] 172 (1935).

[6] R. G. O'Meara and B. W. Gandrud, "Concentration of Georgia Kyanite Ore," *Mining & Met.*, **17** [350] 118 (1936); *Ceram. Abs.*, **15** [4] 131 (1936).

easily disintegrated by mulling, but the sand and mica provided a cushion which lowered the efficiency of the mill. To eliminate the −20-mesh mica, the −60-mesh sand, and the slime, mullers were developed with provision for a continuous flow of water with a rim discharge at the center.[7] This increased the capacity of the mullers, but it did not entirely eliminate the sand cushion. Clean kyanite crystals were produced by removing the remaining kyanite-sand portion of the charge from the mullers, screening out the −10-mesh sand, and remulling.

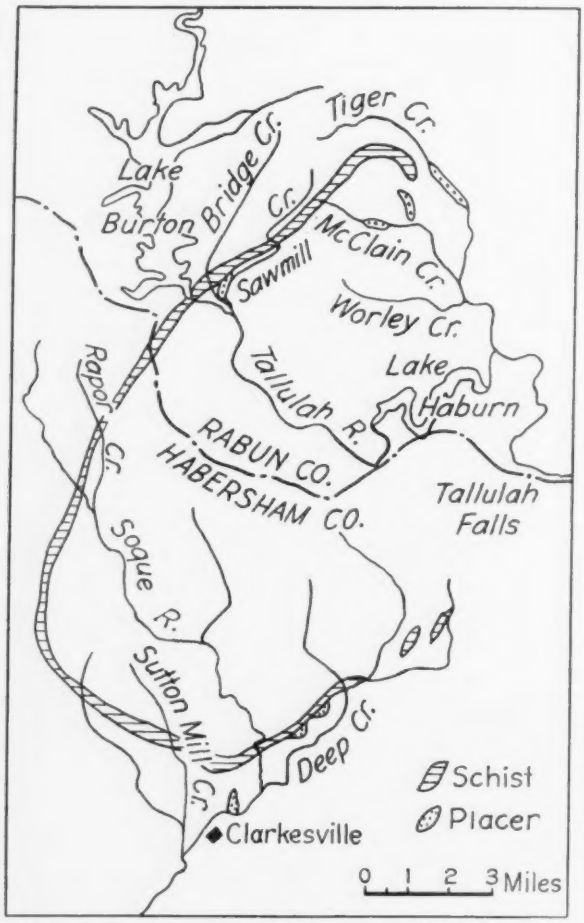

FIG. 1.—Kyanite schist and placer deposits in Georgia.

III. Description of Process

(1) Mining

A $^3/_8$-yard gas shovel is used to strip the overburden from the schist, starting at the outcrop and continuing back ahead of the mining. At a convenient distance from the outcrop, 2 rows of 4-ft. holes are drilled with a jackhammer on 4-ft. centers, and each is shot with 2 sticks of 20% dynamite. This blast splits the rock along the schistosity and dip and provides a bed of a thickness suitable for efficient shovel operation as well as a smooth surface for cleaning up, drainage, and trucking.

The wide area of kyanite schist contains layers of interbedded, impure waste rock, which is removed during mining by a similar procedure.

(2) Crushing and Milling

The rock is passed over a 2-in. grizzly and is crushed in a 10- by 12-in. jaw crusher set at about 1 in. One hundred gallons of water per minute are added, and the grizzly fines are passed under the crusher and through a variable splitter to four 16-ft. mullers, each having two 1000-lb. rubber-covered rollers and turning 11 r.p.m. An additional 50 gallons of water per minute are added to each muller, and the mica and graphite are discharged through a 36-in. center rim overflow.

The feed is adjusted to a rate of about $1^1/_4$ tons per hr. per muller for 3 hr.; it is then discontinued for 1 hr. to permit cleaning the kyanite-sand portion. When the cleaning is complete, gates are opened on the bottom of the muller tubs and the kyanite and sand are flushed out.

(3) Screening and Remulling

The kyanite-sand concentrate thus obtained is washed through a $1^1/_2$-in. screen and elevated to a vibrating screen with 10-mesh and 20-mesh decks. The oversize is remulled, the −10-mesh ÷ 20-mesh material is carried to the mica-tailing table, and the fines, consisting chiefly of sand, are wasted.

The principles and procedure used in remulling differ from primary mulling as follows: (1) Because of the reduced mica content and resulting higher coarse-sand ratio remaining in the concentrate, the mashing or disintegrating action is replaced largely by a scuffing or abrasive action between the sand and kyanite crystals; the mica is thus completely removed from the kyanite with little grinding. (2) Because the mica is finer than in the first mulling process, less water is required to float it, and therefore all of the sand of more than 50-mesh size is left in the muller for scuffing action. The entire charge is added at the start as the cushioning effect of the small amount of mica remaining is negligible. The mullers work individually so that the mulling time may be adjusted for the complete removal of the mica from the kyanite.

(4) Kyanite Concentration

The resulting concentrate is split on a $^3/_8$-inch screen and the −16-mesh material is carried to the sand-tailing dump. The two screen increments are jigged individually on a Joplin-type jig with a $1^1/_2$-in. stroke; its capacity is about 1 ton per hr. The feed to the jig varies from 65 to 85% of kyanite with a discharge of a 95% product. The final impurities consist mainly of quartz adhering to and intergrown in the larger kyanite crystals. Although most of the kyanite is sold in this form, an additional wet-grinding process for a 65-mesh grade (50% of −325-mesh) produces material slightly lower in weathered impurities than the jigged product. Impurities are carried off in the thicker overflow.

[7] Philip S. Hoyt, "Treatment of Kyanite Ore," U. S. Pat. 2,105,597, Jan. 18, 1938; *Ceram. Abs.*, **17** [3] 118 (1938).

IV. Additional Processes Under Development

In cooperation with the Bureau of Mines[6] at Tuscaloosa, successful preliminary research has been completed on a pilot-plant scale on the flotation of kyanite to produce a 97% grade with 0.7% of ferric oxide. This process should reduce both the mulling and the jigging cost because many of the impurities may be successfully removed in the flotation tailings, thereby compensating for the additional cost of this process.

Cationic reagents[8] previously used and a similar flotation process combined with dispersers and depressors adaptable to this ore have been investigated and may be used to replace screening and tabling of the mica. The mica may be recovered at a cost equivalent to the present process and with slightly improved properties.

Acknowledgment

The writer gratefully acknowledges the assistance of Philip S. Hoyt in the preparation of this paper.

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[8] R. G. O'Meara, J. E. Norman, and W. E. Hammond, "Froth Flotation and Agglomerate Tabling of Feldspars" *Bull. Amer. Ceram. Soc.*, **18** [8] 286–92 (1939).

ELECTRIC KILN FOR POTTERY FIRING*

BY F. H. NORTON

ABSTRACT

A wire-wound electric kiln is described which has proved to be satisfactory in the laboratory for firing biscuit and glazes. The advantages of this kiln are such that studio potters may wish to duplicate it.

I. General Design

The design was laid out to provide an inexpensive whiteware kiln of sufficient capacity to take sculptural pieces or large vases. The kiln incorporates the following useful features: (1) it can reach temperatures necessary for whiteware bodies (cones 6 or 8); (2) it provides perfect uniformity of temperature; (3) the setting is simplified by completely opening the opposite sides of the kiln; (4) it provides an increase in thermal efficiency to keep the cost of power low; and (5) the construction is simple so that the cost is reasonable and amateur construction is possible.

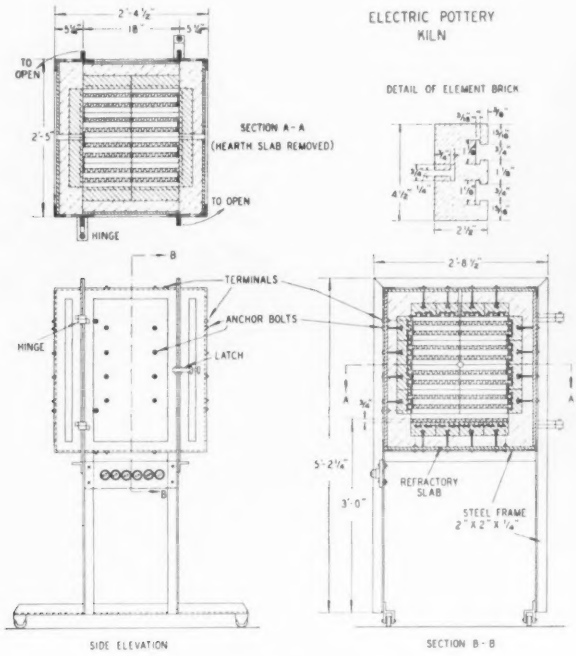

FIG. 1.—Electric pottery kiln.

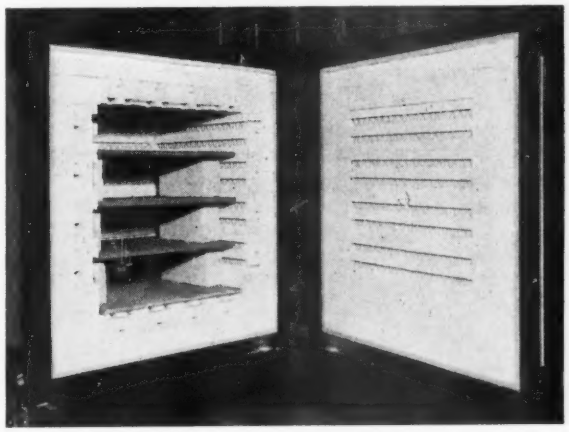

FIG. 2.—Interior of kiln.

II. Detailed Design

A detailed drawing of the kiln is shown in Fig. 1, which should give all of the necessary constructional details. Figure 2 shows the interior of the kiln and the winding and the placing of the shelves. The winding exposes a large radiating area to the interior of the kiln, which permits the high temperatures to be

* Received September 25, 1940.

obtained without overloading the ribbon; at the same time the ribbon is thoroughly supported and permitted to contract and expand without restraint. These three features are absolutely necessary for success in high-temperature, wire-wound kilns. To assist those constructing such a kiln, the following bill of materials, which will cost about $100, should be helpful:

40 ft. of 2- by $1/4$-in. angle iron (frame welded with butt joints)
4 hinges
2 latches
6 10-amp., 2-pole knife switches
60 $1/8$-in. tie bolts (18–8 alloy)
4 heavy casters
$1/2$-in. transite asbestos (Johns-Manville, New York, N. Y.)
2 pieces 18 by $28\ 7/16$ in.
2 " 18 " $28\ 7/8$ "
2 " $28\ 3/8$ " $29\ 7/8$ "
4 " $4\ 1/2$ " $28\ 1/2$ "
4 " $4\ 1/2$ " $28\ 7/8$ "
120 ft. of Kanthal ribbon A-1, 3 by 0.3 mm. (C. O. Jelliff Mfg. Corp., Southport, Conn.)
100 K-30 insulating firebrick, for inner lining (Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.)
100 K-16 insulating firebrick, for Insulation (Babcock & Wilcox Co.)
4 18- by 18- by $1/2$-in. silicon carbide shelves

The windings are arranged so that there is a continuous ribbon in one side of the kiln; in effect, there are altogether six separate elements, each brought out to its own switch on the side of the kiln. The ribbon is initially formed in a zigzag shape on a board in which nails have been driven to give the right configuration, and the complete unit is then slipped into place through the T slots in the insulating firebrick. The heating element is quite ductile when it is new and can be readily bent into shape, but after it has been heated, recrystallization starts in. This causes the ribbon to become brittle and care should be taken not to move it. All six elements are placed in parallel on 110 volts, but they may be regrouped for a 220-volt operation.

The slots in the brick are readily cut in a small drill press by making the proper tool and pushing the brick through against a guide. The brick are sufficiently soft so that the cutting can be done rapidly. The T slot on the back of the brick holds a tie bolt which keeps them in place. The tie bolts are made from an "18–8" alloy rod, $1/8$ inch in diameter, with a $3/4$- by $3/4$- by $1/16$-in. "18–8" alloy head riveted on one end.

Casters are put on the kiln so that it can be moved around readily; these, however, are unnecessary if the kiln is to be installed in some permanent location. There is a small sighthole in the center of each door, and one may be placed in the top of the kiln for a thermocouple if desired. When cones are used, they should be placed in a direct line between the two sightholes in the doors; otherwise the cones would not be seen at all because the temperature is so uniform.

III. Performance

Because the heating elements completely inclose the kiln, the temperature uniformity over the working volume is exceptionally good. In fact, no temperature differences have been detected in various parts of the kiln. The kiln operates on 110 volts and will reach a temperature of 2100°F. (cone 3) in 12 hr. with a 32-lb. charge. Temperatures as high as 2230°F. (cone 8) have been reached in this type of kiln, but the length of life of the windings at this temperature is not known. Forty or fifty firings have taken place at cones 4 to 6, however, without any difficulty with the windings.

The efficiency of this kiln, as run on 110 volts up to 2100°F. with a 32-lb. charge, is 7.2%, which is good for a small kiln. In this run, 60.5 kw.-hr. were used, which at a rate of 2 cents per kw.-hr. amounts to $1.21. For a cone 8 firing, the cost would be about $1.50. The control of the temperature is carried out with a variable voltage transformer, but this piece of equipment is comparatively expensive, and sufficiently good control may be obtained by switching the individual elements on and off. Leaving out one element entirely would make one side of the kiln cooler than the rest; by turning off different elements alternately, however, the temperature should be kept fairly uniform and still allow control. With a little experience, the right temperature is reached in a certain number of hours, and the suggestions given in this paper will serve as a rough guide.

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EXPERIMENTAL DATA ON APPLICATION OF A SYNTHETIC ORGANIC PLASTICIZING AGENT*

By F. F. Ogden

Abstract

The results of a laboratory investigation and large-scale trials on a synthetic, organic, plasticizing, and binding agent, C–35, indicate that it has valuable properties useful in ceramic manufacturing.

I. Introduction

A plasticizing agent called C–35 is a water solution of a neutralized, long-chain organic acid condensed with formaldehyde. This designation would also apply to many products on the market and in the laboratories which have decidedly different properties, such as resins, dispersing agents, and tanning agents, all made from the same or similar materials; C–35, however, seems to have unique properties, which are obtained by careful control of reaction conditions.

The agent, C–35, was developed originally to control the viscosity of oil-well drilling fluids. Samples were then tried in clay slips. It was found that C–35 increased the dry transverse strength of a clay body and improved the plasticity and working properties of the clay. The extent of this increase, however, varied greatly. There seemed to be a progressive improvement as the time of contact (blunging time) increased up to and past 24 hr. Such a period for maximum effect was too long, and an attempt was made to determine the cause as well as a means of eliminating this time period.

It was assumed that an increase in dry strength indicates an improvement in plasticity and that dry strength is a fairly good indication of other desirable properties. This, of course, is not strictly true, but with C–35 the assumption is usually warranted within certain limits. Dry strength was chosen as the "yardstick" because it seemed to be the most reliable laboratory method of arriving at any conclusion. The question of plasticity was important, however, and a careful observation was made of the molding or plastic qualities of all of the treated bodies.

II. Experimental Work

The major portion of the experimental work was done with an electrical porcelain body, designated as body No. 30. A 45% slip of this body with the desired amount of agent added was blunged with a power stirrer, drained on a plaster block, wedged, molded into bars, dried, and then tested for modulus of rupture.

(1) Adsorption

When solutions of C–35 are observed under ultraviolet light, they give a characteristic bluish fluorescence, the intensity of which depends on the amount of the agent present. Standards were made up containing known amounts of C–35, and these were compared under ultraviolet light with the filtrates from clay slips, which were blunged for varying lengths of time and which contained at the start of the blunging operation 0.7% of C–35 based on the weight of the clay.

After 1 hr. of stirring, approximately 10% of the agent was adsorbed by the clay or otherwise removed from solution; after 3 hr. of stirring, 20% was removed; and after 16 hr., approximately 90% was removed.

The ultraviolet-light tests were somewhat inaccurate because it was impossible to filter the colloidal particles of clay from the solutions, and the pronounced turbidity caused by these particles under ultraviolet light made accurate comparisons with the standards difficult. It was decided therefore that only the transverse strength tests would be used.

The tests for transverse strength showed that the adsorption theory was in error and that four factors influenced the action of C–35 on the clay, namely, the blunging time, the degree of agitation, the amount of C–35 present, and the acidity of the suspension.

In the first experiments, a laboratory blunger and 0.7% of C–35, based on the clay weight, were used. The effect of blunging time was studied and the results obtained are shown in Fig. 1.

With no C–35 present, the time of blunging seemed to have little or no effect. With C–35, blunging for 1 hr. resulted in a slight increase in dry strength, 3 hr. gave a large increase, and in 5 hr., the curve leveled off. After 16 hr. of blunging, the curve fell off, almost in a straight line, below the strength obtained with 1 hr. of blunging. An examination of the filtrates from these slips showed the same amount of absorption as in the first experiments and a uniform increase in adsorption as the blunging continued. Adsorption, then, was not the answer to the cause of dry-strength increase, and an adsorption of more than 20% of the added solution was undesirable.

A plant experimenting with C–35 had obtained a uniform increase in dry strength with blunging periods up to 24 hr., whereas the foregoing experiment showed the strength to be greatest after about 5 hr. This suggested that the agitation had been too great. A change was made to 140 r.p.m. instead of 360 r.p.m., which had been used previously. The curve obtained in this case was a straight line, giving approximately the same strength after 16 hr. as the peak of the first curve, which explained the difference between the plant results and the preliminary laboratory tests.

(2) Effect of Acetic Acid

If no C–35 solution was used, 0.11% of 28% acetic acid gave a slight increase in dry strength after 1 hr.

* Received October 17, 1938.

of blunging. With a longer blunging period, the dry strength decreased far below the value for an untreated clay. Because the first experiment showed long contact with acid to be undesirable, 0.11% of 28% acetic acid was added to various slips containing C–35 during the last 2 minutes of the blunging. This raised the peak of the strength curve and broadened it out considerably.

Contrary to expectations, when the acid was added at the end of the first hour of the blunging, an even greater improvement was noted. These experiments clearly indicate that acetic acid used with C–35 has a decided advantage.

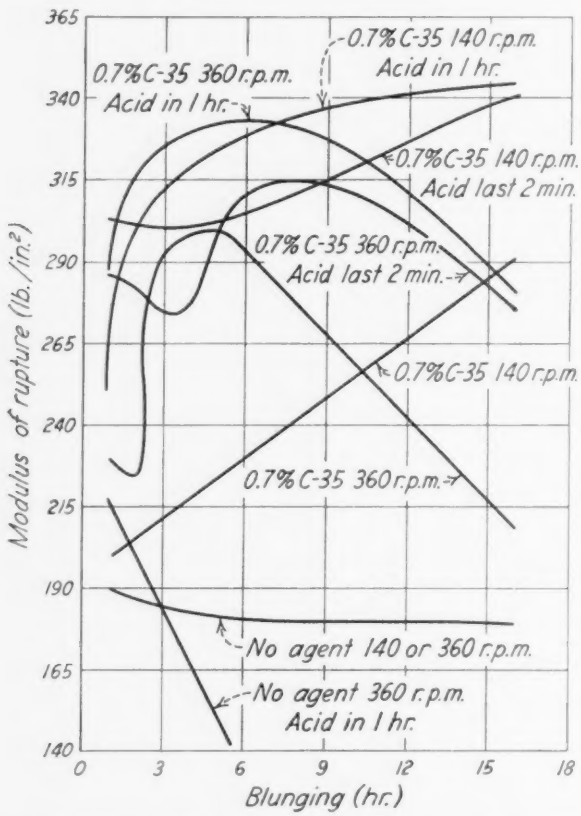
0.7% C-35 360 r.p.m. Acid in 1 hr.
0.7% C-35 140 r.p.m. Acid in 1 hr.
0.7% C-35 140 r.p.m. Acid last 2 min.
0.7% C-35 360 r.p.m. Acid last 2 min.
0.7% C-35 140 r.p.m.
0.7% C-35 360 r.p.m.
No agent 140 or 360 r.p.m.
No agent 360 r.p.m. Acid in 1 hr.
Modulus of rupture (lb./in.²)
Blunging (hr.)

FIG. 1.—Effect of C–35 on transverse strength of body No. 30. Note how the 140 r.p.m. curves continue upward as the 360 r.p.m. curves drop off.

(3) Amount of Agent Used

The fourth factor affecting the dry-strength increase of the bars was the amount of agent used, and the results of this effect are shown in Fig. 2. With 1.4% of C–35, there were even greater dry-strength increases, and the peak on the curves obtained with the 360 r.p.m. agitation was eliminated. Thus any danger of running past that peak and losing the advantages gained by the use of C–35 was also overcome.

The rate of adsorption seemed to be about the same with 1.4% of C–35 as with 0.7%. After 16 hr. of blunging with 0.7% of C–35 added at the beginning, about 90% of this had been adsorbed and removed from solution, whereas when 1.4% was used, about 45% of the agent added had been adsorbed and about 0.8%, based on the clay weight, remained in solution to influence the dry strength.

III. Factory Results

(1) Dry-Press Process

The greatest amount of work was done in plants using the dry-press process. Laboratory experiments apparently require larger amounts of agent than in full-scale practice. The best results were obtained using 0.25% of C–35, added at the beginning of a 3-hr.

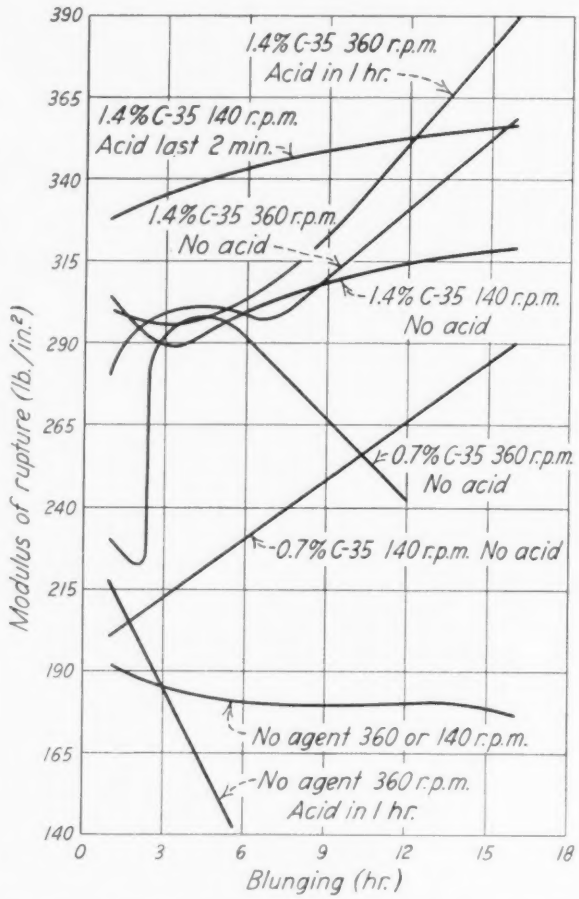
1.4% C-35 360 r.p.m. Acid in 1 hr.
1.4% C-35 140 r.p.m. Acid last 2 min.
1.4% C-35 360 r.p.m. No acid
1.4% C-35 140 r.p.m. No acid
0.7% C-35 360 r.p.m. No acid
0.7% C-35 140 r.p.m. No acid
No agent 360 or 140 r.p.m.
No agent 360 r.p.m. Acid in 1 hr.
Modulus of rupture (lb./in.²)
Blunging (hr.)

FIG. 2.—Effect of C–35 on transverse strength of body No. 30.

blunging period, followed by 0.38% of 28% acetic acid added at the end of 1 hr. Experiments were made on two bodies. The results were so successful that C–35 was adopted as a standard ingredient in all dry-press production.

The use of C–35 seems to result in a firmer, harder body that gives little or no trouble with sticking to the mold. It also permits the formation of a large grain with a small water content. Experimental figures were obtained on this particular phase of the problem by putting some of the filter-pressed clay, treated with various agents, through a pulverizer and agitating it

on a No. 20 screen. With any given water content, the amount of clay remaining on the screen is a good measure of the plasticity and other desirable properties. A clay body was treated with gelatine, lignin extract, sodium silicate, tannic acid, Bindex, yellow dextrin, tetrone B, gum arabic, Daxad, Karo, C–35, and C–35 plus acetic acid, as well as several of the foregoing agents plus acetic acid; C–35 and C–35 plus acetic acid in all cases showed a larger percentage of clay retained on the screen.

With C–35, it is possible to obtain an optimum grain size for dry-press work with a minimum of water content. The improved strength makes possible the elimination of some of the ball clay which permits a better color. It has been found possible, furthermore, because of the better working properties, to produce articles in the dry press which formerly would have been considered impossible.

(2) Jiggering

Not much practical experience has been obtained in the field of jiggering. The gain in plasticity, however, is valuable, and the dry-strength improvement cuts down the rejects caused by cracks. The rejects caused by crooks seem to remain about the same, but more work is needed before any definite conclusion can be drawn. All experiments on the jiggering process were carried out by adding C–35 when the clay went through a vacuum pug mill, the time of contact with agitation being only about 3 minutes. This shows that long contact with the agent is not necessary in all cases.

(3) Slip Casting and Mold Life

As a dispersing agent in casting slips, C–35 is not powerful enough to give results equal to silicate of soda, soda ash, and other compounds now commonly used. A special type of C–35, known as C–35 10P, however, seems to retain the advantages of each agent and to decrease the attack of the molds to below that caused by silicate and soda ash.

Small pieces of plaster molds were placed in solutions of C–35 10P and sodium silicate, which were made up to concentrations encountered in use. The piece of mold in the silicate solution lost 7.28% of its weight in 6 days, whereas the piece treated with C–35 10P lost 2.40% of its weight, which indicates an advantage in the use of this agent.

Two to three times as much of C–35 10P is generally needed to bring about a viscosity reduction equal to that obtained with silicate and soda ash. There is reason to believe, however, that the following advantages in using C–35 10P offset this one disadvantage: (1) it reduces viscosity to the same point as other agents, (2) it is 99.9% volatile, (3) it will increase dry strength, and (4) mold life should be increased.

IV. Conclusions

It is difficult to formulate any theory with such complex molecules as C–35 and clay entering the reaction. It seems probable, however, that C–35 has three functions, namely, (1) as a dispersing and viscosity-reducing agent, (2) as a protective colloid, and (3) as an organic binder.

The dispersing action causes a reduction in viscosity, and through this reduced viscosity the mechanical energy put into the slip by the blunging action is better utilized. A better grading of the mix is obtained because the clay is broken up more than usual and the particles are broken down to a smaller ultimate size than the untreated clay. A ratio, more nearly optimum, between large and small particles is secured, and this results in a higher strength. When the clay is blunged with C–35 and filter-pressed, there can be little action as a binding agent because approximately 80% of the C–35 added at the beginning of the operation is removed in the filtrate.

When C–35 is applied in a vacuum pug mill, it seems improbable that it has much dispersing action on an acid-flocculated clay already in a plastic condition. In this case, it is believed that C–35 is acting as an organic binder. It seems reasonable to suppose that, under the influence of the acid condition, hydration of C–35 takes place and that it assumes a gel structure, which is an effective binding medium after it is dry. The theory of gel structure is supported by the fact that, if the C–35 condensation is carried on beyond the proper limits, there is a point where a jelly is formed before condensation into a hard, insoluble resin takes place. This gel structure serves to distribute the C–35 more or less evenly throughout the mass and gives strength to the dried product.

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MANUFACTURE OF LIGHTWEIGHT PRODUCTS*

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Abstract

In the sense used in this paper, the term "lightweight" refers to those construction materials which have a density of from 30 to 60% of that obtained when the customary method of working up the raw materials is used. The various processes which have been developed for obtaining levity have been grouped as follows: (*a*) the use of large voids in the shape, (*b*) the inclusion of combustible material, (*c*) the inclusion of materials which are removable by evaporation, solution, or sublimation, (*d*) the incorporation of natural or synthetic lightweight materials, (*e*) the formation of small cells during firing, and (*f*) the formation of small cells in the semifluid or plastic material prior to firing. These processes are briefly described.

I. Introduction

There are numerous ways and means of producing lightweight materials. Before deciding whether the use of any one method or combination of methods is suited to the individual requirements, the manufacturer must have a survey, more or less historical in nature, of all known processes. Such a survey has prompted this paper.

II. Scope of Survey

The methods of producing lightweight products may be grouped into six classes: (1) the use of large voids in the shape, (2) the inclusion of combustible material, (3) the inclusion of materials which are removable by evaporation, solution, or sublimation, (4) the incorporation of natural or synthetic lightweight materials, (5) the formation of small cells during firing, and (6) the formation of small cells in the semifluid or plastic material prior to firing.

(1) Use of Large Voids in the Shape

In this class, large voids have been emphasized. The group is meant to include such products as hollow clay tile and hollow glass brick, which have been made possible through mechanical development and therefore are mechanical in nature. Hollow tile has been improved from time to time through a change in design. These improvements have generally been made for purposes other than the reduction in weight.

(2) Inclusion of Combustible Material

The original method of obtaining light weight in clay products consists of the addition of combustible fillers to the clay mixtures which may be consumed during the firing process to leave voids or cells. The amount or kind of filler that can be used is limited. Efforts to push back these limits have resulted in certain special treatments and in the use of certain combinations of materials.

The material originally used as a filler was wood sawdust. No thought was given to the kind or size of sawdust until 1844,†,[1] when an effort was made to grade to size and to include a combination of two or more combustible materials in the clay mixture. Two years later,[2] chopped straw with spent tanner's bark and charcoal were used. Such materials were in use quite generally for thirty or forty years until process improvements were made.

It was suggested in 1886[3] that successive layers of straw and clay might be soaked and aged together so that during the subsequent extrusion process the lengths of straw might be oriented and stretched to give high bond strength and to make possible the production of larger pieces of ware.

Thirteen years later, Grünzweig[4] mixed kieselguhr and clay with ground cork and pressed them together to form a heat insulator. The clay was used to bond the kieselguhr when the insulating material was used at temperatures high enough to consume the cork. Grünzweig unwittingly made a ceramic insulator. Soon after this, sawdust and other organic materials were used[5] in kieselguhr to improve the mixing.

More recently a host of untreated combustible materials, such as sulfur and powdered coal,[6] hair and shoddy,[7] lignite clay,[8] lignite coal,[9] kernel shells,[10] and others,[11] have been used as fillers in clay in addition to or in place of sawdust.

Some combustible materials may be pretreated to obtain certain effects. Cork may be expanded by preheating[12] to avoid swelling within the clay and rupturing of the formed body. For much the same reason, peat refuse[13] can be preheated with an aqueous solution of saponified resin and pitch. When alumina and ferric oxide[14] are added, they fuse with and bind the silica. Bentonite[15] may also be used with less refractory bodies.

Modifications of the method of forming or shaping have also been suggested. The combustible material-clay mixture may be cast,[16] presumably to give greater cellularity with subsequent higher strength. Injection molding may also be used.[17] A certain amount of plaster of Paris is often mixed with the body in such cases. Additional levity may be obtained by aeration[18] of the sawdust-clay mixture before it is cast.

Only one attempt is recorded to include admixtures which, in decomposing during the firing, will generate

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† The reference numbers given throughout this survey refer to the numbered references in the Bibliography, pp. 471–73.

oxygen within the body and insure more complete combustion of the filler material.[19]

An insulating product made of clay is usually trimmed or cut down to a standard size. This operation leaves open cells on the surface. It has been suggested that the brick be made with a dense fire-clay shell[20] to overcome the necessity of having open cells at the surface.

(3) Inclusion of Materials Removable by Evaporation, Solution, or Sublimation

Processes which may be classed under this heading have not been used extensively. The first application consisted of the use of pellets of paraffin[21] which were uniformly mixed with the material and later extracted by means of solvents. A rather novel application was used in the manufacture of so-called ice concrete,[22] wherein small pellets of ice, hailstones, and the like were coated with plaster of Paris or other rapidly setting cements and incorporated in concrete. The gradual melting of the ice furnished the water needed for the hydraulic setting of the cement and left voids in the concrete.

In a similar way hydrocarbons, such as naphthalene[23] in comminuted form, have been incorporated in plastic clay bodies. After the body is dried, the hydrocarbons are extracted by sublimation at low temperatures. An insulating body is left that is difficult to fire thoroughly. The addition of combustible materials, which during firing will heat the interior of the shape and give more uniform firing,[24] has partly overcome this obstacle.

(4) Incorporation of Natural or Synthetic Lightweight Materials

Diatomaceous earth brick sawed from the natural bedding is an early form of natural lightweight insulating material. Scrap or waste from this sawing operation can be bonded with calcium oxide and clay.[25] It can also be hardened by firing[26] and, after sizing, can be bonded with plaster of Paris or high alumina cements.[27] The finely ground diatomaceous earth may be intimately mixed with a fibrous material such as asbestos and then molded under pressure, the bond being obtained by the network of fibrous material.[28] It may also be mixed with lime or lime and silicate of soda, and after it is shaped it may be hardened by the application of high-pressure steam.[29]

Diatomaceous earth, either raw[30] or precalcined at a low temperature,[31] may be mixed with clay that will mature at a low temperature to give strength to the final product. The silica inversion limits the temperature to which such material can be used. These temperature limits, however, may be raised if the earth is precalcined to a sufficiently high temperature to convert it almost entirely to tridymite.[32]

Exfoliated vermiculite can be used in much the same manner as diatomaceous earth.[33] Much of the levity of this material would be lost by permanently filling the spaces between the exfoliated flakes of the individual pellets. This loss can be avoided to a certain extent by filling the spaces with a viscous starch material[34] before mixing with the clay or cementitious binder.

Insulating products made with these lightweight filler materials can be used only to comparatively low temperatures, 2000° to 2200°F. Efforts have been made to increase refractoriness by substituting preexpanded refractory ceramic products.[35]

(5) Formation of Small Cells During Firing

The fundamentals of this process for obtaining levity were not recognized until the past quarter century. The process consists of the generation and entrapping of gas when the materials are at or near the point of fusion. The first application of the process was made with molten blast-furnace slag, which was poured on water and manipulated so that steam was entrapped to vesiculate the slag.[36] The vesiculated material was then formed into shapes, generally by bonding with cements. A modification[37] consisted of including in the slag an admixture which would generate gas at temperatures above the fusion temperature of the slag and which would be entrapped in the viscous molten mass.

The best known clay fire-expanded material is known as Haydite, so named after the inventor, Hayde.[38] It is strictly a lightweight concrete aggregate. The process consists of heating raw shale rapidly in a rotary kiln in which the final temperature of approximately 2000°F., or 100° to 150°F. above the temperature used for brick, is attained in about two hours. This temperature must be regulated so that incipient fusion will take place at least on the surface of the individual particles and form an envelop to entrap the gases generated in the interior, thereby causing the expansion and lightening of the product. After being expanded, the product is crushed or broken down to a size suitable for use as an aggregate.

There have been several modifications of the fire-expanding process.[39] A so-called improvement[40] consists of preparing the raw shale, with or without a gas-generating admixture, by forming it into individual pellets or balls and coating them with a highly refractory siliceous material, such as fire clay or diatomaceous earth, to prevent sticking and conglomeration during the expansion process.

Although the fire-expanded clay materials have been primarily used as aggregates, several processes have been developed[41] to shape them, while hot, into ceramic-bonded building units. These methods consist either in expanding the material in molds that will not be affected by the high temperature or of reworking and shaping the expanded semimolten material in much the same manner used in forming steel shapes.

(6) Formation of Small Cells in Semifluid or Plastic Material Before Firing

The formation of small cells by entrapping air or gas in the material while it is in the fluid or plastic state has received by far the most attention. The earliest work of this nature was done by Sanford[42] in 1880. His invention consisted of a composition having a spongy, porous, cellular formation caused by the chemical union of the components, thereby generating gas in the semifluid, moist, and plastic material and entrapping

these gas bubbles as the mixture set or hardened. The principal ingredients of Sanford's composition were bicarbonate of soda and plaster of Paris. He also claimed certain advantages in the addition of such materials as wheat flour, pulverized rosin, glucose, glue, molasses, glycerine, and other glutinous, mucilaginous, saponaceous, or gummy materials. He states furthermore that sulfuric acid, sulfate of iron, sulfate of zinc, alum, and acetate of lead may be used instead of bicarbonate of soda as a leavening agent in admixtures with cement, clay, and ashes. To increase the bulk and to lighten and cheapen the product, such materials as paper pulp, charcoal, coke, cinders, shavings, sawdust, hay, straw, chaff, hulls of grain, rice, and hair may be added.

The Sanford patent seems to cover, or at least to anticipate, nearly all phases or possible alterations in the process of producing porous materials by the generation of a gas within a semifluid or plastic body. It is significant, however, that this process was not applied to commercial practice for thirty or forty years. Perhaps the answer to this is given by the inventor himself when he stated that the conditions must be just right to give the right amount of gas and that the expertness of the operator in attaining the proper conditions will best be attained by practice.

There is no doubt but that the merits of the Sanford invention have been recognized because much research work and development have since been made. A similar process has been used for aerating finely pulverized asbestos waste.[43] The surfaces of shapes of such material were coated with fibrous asbestos mixed with sodium silicate.[44]

When calcium carbonate and aluminum sulfate were first used as gas-generating ingredients in gypsum, it was found that the gypsum set before the completion of the gas-generating reaction and that high internal pressures were built up which ruptured the body. This was overcome by controlling the time of set of the gypsum by means of the proper proportions of commercial retarder[45] or by the inclusion of hydrated lime and oxalic acid.[46] A product thereby has been developed for filling the spaces in a hollow wall to provide insulation.[47]

In the employment of a gas-generating medium in a semifluid mixture, there is always a tendency for the gas cells to rise to the top and escape. This may be avoided to a certain extent by the use of admixtures of dextrinized starch and soap bark,[48] magnesium silicofluoride,[49] sulfonic acid salts,[50] benzoic acid,[51] and other nonwettable ingredients, such as talc, silica, lamp black, and gum arabic,[52] which will concentrate or collect at the surface of the cells to strengthen the cell walls.

Instead of using chemical ingredients that generate carbon dioxide as a cell-forming gas, other ingredients that liberate oxygen may be used. Such ingredients are hydrogen peroxide with blood flour, a by-product of the packing industry,[53] or potassium permanganate and calcium hypochlorite.[54]

The production of levity by the generation of a gas within a cement slurry must be carried out under alkaline conditions. This may be accomplished by the addition of metals, such as aluminum and zinc, to cement which will react to form a gas when mixed with water. If necessary, an alkali is also added.[55]

An entirely different method of obtaining levity in cement products consists of the addition of frothing compounds to the cement, which permits the production of a foam *in situ* through mechanical agitation.[56] The amount of levity may be easily regulated by the addition of the proper amount of the frothing compound or by the amount of agitation.

All of the methods of producing lightweight products, which have been described, will give relatively large cells or voids. If an equal volume of small cells is used instead of the larger cells, the strength will be greatly increased. A process[57] has been developed with materials containing a large percentage of hydrated lime in which a slurry is caused to gel or set and entrap the water mixed therewith. This product is then hardened under steam pressure and dried. The space which had been occupied by the interstitial water consists of pores which are microscopic in size. Additional levity may be obtained by combining this process with some of the gas-generation methods.

The first real attempt to expand clay products was made by mixing with the clay slurry a tenacious foam, which had been prepared from a water solution of soap bark, licorice, commercial plaster retarder, glue, soap, or rosin soap.[58] Stiffening or setting was aided by a small amount of plaster of Paris. This process was not used extensively at first because of the difficulty of procuring a really tenacious or stable foam.[59]

The application of any of the methods of expanding clay materials presents a problem entirely different from that encountered with cementitious materials. The shrinkage of clay products during the drying or hardening process presents a problem not encountered in the application of methods for expanding cementitious materials.

Efforts have been made to overcome the high shrinkage of expanded clay products by the addition of dehydrated clay and a hydraulic cement.[60] The surfaces of the cast shape in one case have been impregnated with a binding agent to prevent surface cracking.[61] In another case, the clay has been deflocculated to reduce the amount of water needed to attain sufficient fluidity for expanding and then causing delayed flocculation to stiffen or gel the cast mass.[62] The simplest means of setting the cast, semifluid-expanded mass is by the inclusion of plaster of Paris which, in setting, not only takes into chemical combination a part of the water of fluidity but also strengthens the cell walls by a crystal growth of the gypsum.[63] This is assisted by the inclusion within the batch of a carefully controlled proportion of calcined grog[64] or previously expanded material[65] to absorb the water of fluidity from the expanded mass. Such action will stiffen the mass by means of what may be termed "internal absorption." Attempts have also been made to accomplish the same thing by adding dry or calcined clay after the mass has been expanded.[66]

Another method of expanding a clay slip has been used[67] in which sodium silicate was included in the slip.

After the expansion, an acid or acid gas was added to cause the slip gradually to gel and stiffen. This process may be reversed by expanding a clay slip, which is acid in character, and subsequently adding powdered sodium silicate to cause gelation of the expanded mass.[68] There are modifications of this process.[69]

Other processes of producing various lightweight clay or refractory insulating materials are expanding with gas a mixture of clay and comminuted combustible material,[70] mixing clay with water containing a soluble gas that is later released by heating,[71] chemically expanding sized raw kyanite mixed with a small amount of clay for binding,[72] the production of a refractory cement which can be expanded by the common methods and which will hydraulically set,[73] melting a refractory oxide and forming it into small spheres to be bonded into shapes by a refractory cement,[74] expanding a clay slip by means of a fermentation-producing agent,[75] and the inclusion of emulsifying agents that will make aeration more easily attainable.[76]

III. Conclusions

From this review of processes of producing lightweight materials, it is apparent that the production of porous products is an art having many different phases. Quite satisfactory materials may be produced by some of the processes. Cheaper materials can be produced by other processes, but they will not be suitable for all purposes because of certain inherent characteristics, such as low strength, low refractoriness, etc. The process to be used therefore must be selected on the basis of the requirements of the ultimate product.

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COMPARISON OF EFFECTIVENESS OF HEADER COURSES AND METAL TIES IN BRICK WALLS*

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Abstract

The structural behavior of walls and the resistance of their unit plates to buckling are described. A study was made of the relative behavior of transverse units ("headers") or metal or mortar ties in standard brick, double brick, and miniature wallettes. The authors recommend certain revisions in current practice to permit the use of adequate metal ties in place of headers for walls subjected to axial compressive loads. A continuation and extension of the present studies is also recommended.

I. Introduction

A wall, in terms of structural mechanics, is a flat plate in a vertical position subjected to compressive loads along its edges. The behavior of a wall depends on the relation between wall thickness and height. The load-carrying capacity of a relatively low, thick wall is determined by the resistance of the material to crushing. Relatively high, thin walls fail by buckling. The action of walls of usual proportions is a combination of the two and appears first as a tendency to buckle, causing localized compressive stress of high intensity locally crushing the material, which reduces buckling resistance and finally permits buckling of the entire assembly. Resistance to buckling is the determining factor of wall strength.

The tendency to buckle is due to lack of symmetry of the loads, of the wall, or of both. It may occur because of eccentric or off-center load application or side loads on the wall. Lack of symmetry of the wall due to variation in workmanship or material also results in an unsymmetrical condition even though the forces may be concentrically applied. Practically, in spite of all attempts to insure perfect symmetry, the tendency to buckle is inevitable. Resistance to buckling is the characteristic that actually determines the structural efficacy of the wall.

Masonry walls are assemblies of units arranged in a standard pattern and bedded in mortar. Wall thickness, ordinarily expressed in inches, may be described as one, two, three, or more units thick. In effect, a masonry wall is composed of a series of adjacent flat plates one unit thick. The buckling resistance of walls of unit thickness depends largely on workmanship and to a less extent on the properties of the brick or tile and mortar. The buckling resistance of walls of two or more units is determined by the extent to which they act as a single thick plate rather than individual thin plates. The effectiveness with which the unit plates are tied together is the factor which determines the buckling resistance of a multiple wall.

The mathematical criterion of resistance to buckling is the slenderness ratio which, for a theoretical wall, is the unsupported height divided by 0.288 of the thickness. For a given wall height, therefore, buckling resistance is directly proportional to effective wall thickness, which is the thickness of the portion of the wall that acts as a single plate. The optimum condition is obtained by so joining the adjacent unit thicknesses that they act together as a structural unit. This is accomplished by means of transverse units or "headers" arranged in a pattern of courses or by metal or mortar ties.

Moisture conducted through masonry walls by capillarity is closely associated with header units and courses. The elimination of headers by the use of metal or mortar ties should greatly reduce the amount of moisture so conducted and at the same time may improve the structural behavior of the wall. It is the purpose of this study to consider the relative effectiveness of headers and ties together with slushed and grouted wall joints in accomplishing the unification of adjacent plates of unit thickness.

In the experiments on which this study is based, the size and the number of the test specimens were restricted by the available facilities. The results and conclusions therefore should be regarded as indicative of feasible improvements in practice rather than as conclusive proof. Laboratory tests should be used for judicious inference rather than as a literal guide. Conclusive proof is found only in actual practice.

Full participation of thin laminae or plates as components of a thicker plate in resisting edge loads, which tend to cause failure by buckling, is assured when they are securely attached along their faces. Cracking or separation of material is caused either by tension or shear or by a combination of the two. An appraisal of the situation in a masonry wall indicates that the separation of the layers is due principally to slippage or shear parallel to the faces and in a negligible amount to tension normal to the faces. Resistance to direct shear along the plane between the two unit thicknesses, for this reason, was adopted as an indication of the effectiveness of the ties between the plates.

II. Test Procedure

The resistance to shear along the plane of contact of two plates of unit thickness indicates the effectiveness of the manner in which they are tied together; the behavior during the test, as well as the strength, is a basis for predicting the performance in practice. Wallettes, two units thick and as large as could be accommodated

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by the testing machine, were placed in eccentric compression by supporting one unit plate and loading the other. The eccentricity of load on the testing machine was reduced by a slight inclination of the specimen, obtained by machining one leg of a 4-in. structural angle to a slope of 1:8, which was used as the top and bottom bearing device. The inclination had a negligible influence on the shear load but induced a slight compression component between the faces. As the tests were for comparative rather than for quantitative use, the influence on the results was disregarded.

The capping and cushioning material between the brick and bearing angles was $^3/_8$ in. of Celotex, which functioned well in all respects.

Wallettes 1 to 10, inclusive, were tested in the inclined position shown by Fig. 1. Wallettes Nos. 1′, 2′, 11, and 12 were in a vertical position.

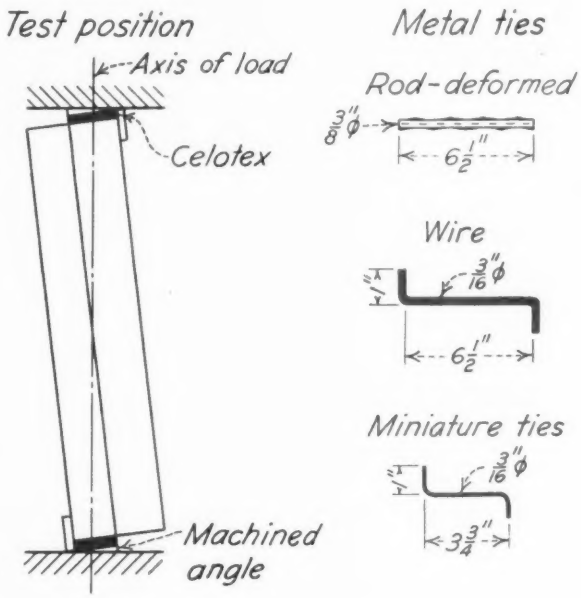

FIG. 1.

III. Test Specimens

Three types of units were used, viz., standard common brick, double brick, and miniatures cut from tile stock to the dimensions of $1^3/_{16}$ by 2 by $4^5/_{16}$ in. Wallettes, 2 units thick, 3 stretchers long, and of the height and details shown by Figs. 2 and 3, provide the data of this study.

The mortar was lime and cement proportioned by volume; 1 part of lime putty, 1 of Portland cement, and 6 of mortar sand; all mortar joints, including the wall joint, approximated $^1/_2$ in.; all miniature joints approximated $^1/_4$ in.

The grout of wallettes 5, 6, 8, and 9 was proportioned by volume; 1 part of cement, $^1/_4$ lime putty, and 4 of mortar sand; the thickness of the grouted wall joints of these specimens approximated $^3/_4$ in.

The specimens were prepared, cured, and tested in a manner as uniform as possible. The test age was 28 days, both for uniformity and possible correlation with other test data.

The wire ties were cut from $^3/_{16}$-in. hot-drawn mild steel wire and were prepared as shown in Figs. 2 and 3. The rod ties were $6^1/_2$-in. lengths of standard, deformed $^3/_8$-in. round reinforcing bars.

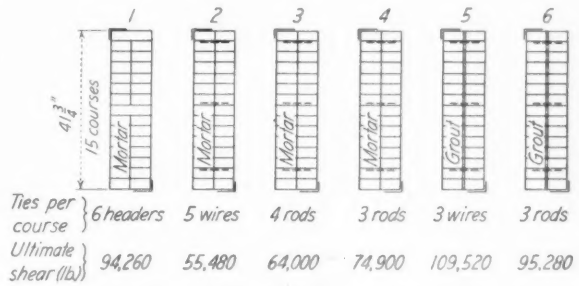

FIG. 2.—Standard brick wallettes (3 stretchers long).

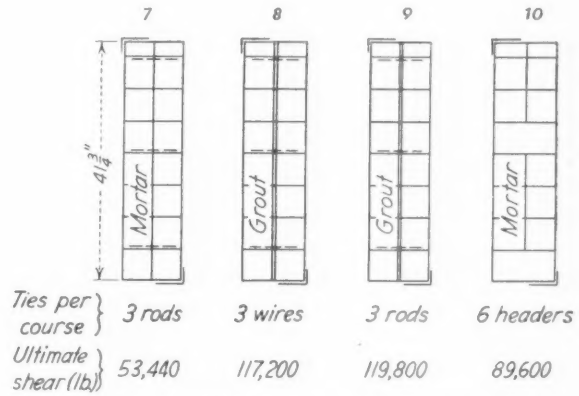

FIG. 3.—Double-brick wallettes (3 stretchers long).

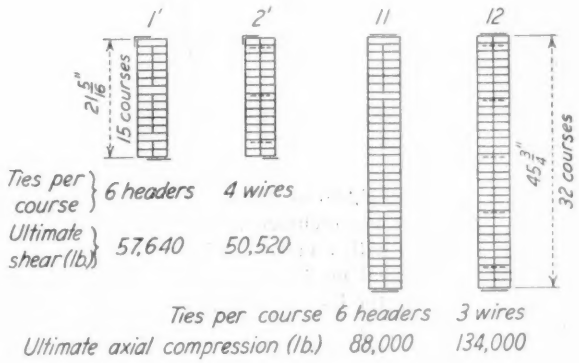

FIG. 4.—Miniature wallettes (3 stretchers long).

IV. Test Results

Beneath each of the specimens diagrammed in Figs. 2, 3, and 4 is the ultimate load indicative of its maximum test resistance. Detailed descriptions of the sequence and the manner of failure for each case follow.

Standard Brick Wallettes

(1) The load was applied at a uniform rate to 94,260 lb., at which point the top header course sheared together with the upper half of the slushed wall joint; the load dropped to 62,860 lb.; loading was resumed, and at 65,900 lb., the middle and lower header courses sheared. A following load of 94,260 lb. would have caused complete shearing of the three header courses and of the wall joint. The shear plane was almost exactly transverse of the headers.

(2) The load was applied at a uniform rate without signs of distress to 55,480 lb., at which the wall joint sheared. This shearing failure included some faces of the brick, some bond failure, and a slight amount of shear of the mortar. The ties, which supported a load of 21,640 lb., remained intact with no cracking of the horizontal or vertical mortar joints. Loading was resumed and continued until a shear displacement of about $^3/_8$ in. was reached. During this period, the load fluctuated between 18,000 lb. and 21,000 lb. Cracking of the top horizontal joint on the unloaded side occurred. Investigation of the ties revealed that they had been uniformly elongated about $^1/_8$ in. The angle of the hooks was not changed and the bond was unbroken. Their embedment, however, was weakened by the shearing of the mortar included in the area affected by the hooks, permitting a slight horizontal motion of the hooks.

(3) Shearing of the wall joint occurred at 64,000 lb. with no previous signs of distress. A 41,400-lb. load remained on the ties. Continued loading was accompanied by a gradual load reduction to 32,000 lb., at which point the top stretcher course and the lowest two courses were pried loose at a shear displacement of $^1/_4$ in. The specimen was broken open, and a slight slippage of the ties was observed, caused by shear failure of the mortar rather than by bond failure. No localized crushing due to bearing of the bars was found.

(4) No effects were observed until shear of the wall joint occurred at 74,900 lb.; the load remaining on the ties was 32,940 lb. Continued loading showed a gradually decreasing resistance to 23,000 lb., at which point the top stretcher course and the lowest two courses on the opposite side were pried loose. Inspection of the ties revealed conditions identical with those of paragraph (3).

(5) A load of 109,520 lb. caused shear failure along the wall joint, which included shearing of some faces, and bond failure with no shear in the grout; a load of 66,000 lb. remained on the ties. The resumption of loading increased the force to 74,800 lb., at which point the load suddenly dropped to a negligible amount with apparent failure of the ties. Subsequent examination revealed that the ties had not failed, but the hooks had sheared through the mortar of the horizontal joints.

(6) Shear of the wall joint occurred at 95,280 lb., and the resistance dropped to 56,680 lb. Resumed loading developed a force of 74,800 lb., which caused sudden failure of the upper half of the unloaded side due to the leverage of the middle course of rods.

(2) Double-Brick Wallettes

Specimen No. 7 showed a resistance of 53,440 lb., at which shear of the wall joint occurred; a load of 20,300 lb. remained on the ties. Increased displacement caused the courses above the upper rods and below the lower rods on the unloaded side to be pried loose.

In No. 8, a load of 117,200 lb. caused shear of some faces and bond failure on others; 47,000 lb. remained on the ties. When the load was increased to 53,400 lb., an opening occurred in the horizontal joint at the upper ties. Shear of the mortar induced by the hooks but without straightening the hooks was observed.

Shear along the grouted wall joint (No. 9) was caused by 119,800 lb. Cracking open of the horizontal joints carrying the rods followed immediately, and a negligible residual strength remained.

Specimen No. 10, with double-brick headers, developed a resistance of 89,600 lb., which caused shearing of all headers and the slushed wall joint.

(3) Miniature Wallettes

Miniature brick cut from tile stock were used to approximate similitude of full-scale units and to represent the approximate equivalent of standard walls of corresponding slenderness ratios. Specimens 1′ and 2′ were built and tested as a preliminary study of possibilities of the tests of standard brick and double-brick wallettes. They are included as a matter of record and to indicate the close correlation with the behavior of full-sized units.

Shear specimen No. 1′ failed in shear of all headers and slushed joint at 57,640 lb.

Shear specimen No. 2′ failed in shear of the wall joint at 50,520 lb. A resistance of 24,000 lb. was developed by the ties which at a shear displacement of $^1/_4$ in. showed elongation and shearing of the mortar of the horizontal joints due to the hooks.

Specimen No. 11 is intended to represent the action of a standard header wall under a symmetrically applied axial load. At 88,000 lb., shear failure of all headers and of the wall joint occurred. Continued loading caused sudden failure by buckling. Under a following load, this undoubtedly would have occurred simultaneously with the shear failure. The slenderness ratio of this wall is 37.2.

Wallette specimen No. 12, with a slenderness ratio of 37.2, is intended to represent an 8-in. wall of standard brick, 86 in. high. Its behavior is comparable with that of No. 11. At a concentric axial load of 134,000 lb., failure by crushing of the units in the region of three-fourths of the height appeared. Continued loading caused an increased rate of spalling with no cracking observed along the wall joint. Subsequent examination of the ties revealed no evidence of severe stresses in them and no failure in shear or bond. The intensity of compressive stress in this wallette at failure was 2360 lb. per sq. in.

The wall joint was slushed in this case, but because of the proportions of the miniatures, it is probably more nearly the equivalent of a grouted than of a slushed joint in the prototype.

V. Interpretation of Test Results

Quantitative interpretation of the results of these tests in terms of stress intensities is hardly justifiable. The behavior of the wallettes during the application of load and the manner of their failure are more productive of information on which to base the exercise of engineering judgment than the numerical data which were obtained. All specimens except No. 11 and No. 12 were loaded in a manner that has little practical significance, with the single purpose of comparing the behavior of headers and metal ties and of observing the influence of slushed and grouted wall joints. No reliable scientific data are available on the requisite strength of ties to develop the column action of masonry walls. Experience and custom are the only guides, and departure therefrom is a matter of judgment. It is intended that these tests provide some basis for the exercise of such judgment.

Careful observation of the behavior of the specimens seems to justify the following interpretations:

(1) The principal source of shear resistance is the wall joint. The strength of this joint depends on the strength of the mortar or grout and on the workmanship. A cement grout of the proportions used in these tests is sufficient to provide greater bond and shear resistance than that of the units.

(2) Headers have less shear resistance than an equivalent grouted area and somewhat more than an equivalent slushed joint of cement mortar when it is used with metal ties. The primary function of headers and metal ties is to provide the tensile resistance necessary to develop the shear resistance of the wall joint.

(3) A comparison of the two types of ties used in these tests indicates that the wires were as effective as the rods in developing the shear resistance of the wall joint.

(4) Both types of tie, the deformed bar and the hooked wire, develop sufficient anchorage to cause failure in other respects; in the dimensions used, the hooked wire has better anchorage than the rod.

(5) Metal ties have residual strength after slippage of the wall joint, whereas headers fail with the joint and thereafter cease to function.

(6) The necessary number of ties appears to be somewhat less than that used in the test specimens.

(7) A comparison of the miniature wallettes No. 11 and No. 12 shows a marked advantage of the metal-tied wall with a slushed wall joint over the typical header wall for ordinary compressive loads.

(8) This series of tests has reference only to walls with slushed or grouted wall joints.

(9) The shear resistance of a grouted wall joint may be increased by partially filling the horizontal and vertical joints to permit the grout to flow into them. The use of units with roughened interior faces will also increase the shear resistance by providing a better bond.

VI. Recommendations

Certain revisions in current practice are suggested by this study:

(1) The use of adequate metal ties in lieu of headers for walls subjected to axial compressive loads is acceptable when the wall joints are properly filled with cement mortar or grout.

(2) The increase in strength of a metal-tied grouted wall should justify a corresponding increase in allowed stresses consistent with the quality of the units and of the mortar.

(3) Dependence on the bond of a slushed or grouted joint to join adjacent wythes without the aid of ties, headers, or their substantial equivalent is inadvisable.

(4) Observations of the test specimens (under conditions that cannot possibly be duplicated in practice) justify the recommendation that the use of metal ties of wire of not less than $^3/_{16}$ in., with hooks or straight corrugated bars of larger diameter in the number of one per stretcher in every sixth horizontal joint of walls with slushed or grouted wall joint, will assure adequate joining of the wythes or plies and satisfactory structural behavior of the wall.

(5) Present knowledge of the mechanics of masonry walls is far from complete. Notable contributions on this subject have been made as a result of studies at the National Bureau of Standards and at several university laboratories. The need for continuation and extension of these studies is apparent when it is observed that current design is still based largely on tradition rather than on authoritative scientific information.

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON

Only twenty-two more Personal Members needed to make the all-time high of Paid Personals. Here is a Booster Offer. New Personal Members enrolled in December may elect to

(1) pay the full $12.50 for 1940 membership and receive all of the 1940 publications or

(2) pay $12.50 and join as of 1941 and receive the December, 1940, issues (which include the indexes) as a bonus.

CERAMIC HISTORY

CHAUNCEY E. FRAZIER

Chauncey Earl Frazier, of Washington, Pennsylvania, known throughout the world as a professional engineer in the glass industry, may be properly termed a "pioneer" in modern mechanical engineering development.

Mr. Frazier was born in Butler, Pennsylvania, March 9, 1879, the son of Thomas Alexander (first postmaster appointed by President Woodrow Wilson at Butler) and Harriett (Bickett) Frazier. His parents were of Scotch and Irish ancestry.

He was educated in the public schools of Pittsburgh and Butler County and received technical training in engineering courses of the International Correspondence School and also through self-study and by occupational experience. As a small boy, he developed the attitude of never being satisfied with mechanical equipment as designed. The incentive to do better has become his philosophy of life, a trait essential for progressive development and research.

In 1896, Mr. Frazier first began his professional career as an internal combustion engineer when he installed and operated plants for supplying electric power involving the use of internal combustion engines. During this time he also was an erecting engineer of isolated power plants which embraced the east, southwest, and Mexico.

Several years later, he installed and developed a system of making ingot molds by the direct-metal process for the Thomas D. West Foundry Company, Sharpsville, Pennsylvania. This new process enabled great savings to be realized in the cost of producing ingot molds. During this period, he introduced the straight-line method of fabricating structural steel which has reduced costs in steel fabricating plants. He also did considerable design work in electrifying soft coal mines, which has reduced the cost of mining coal.

From 1903 to 1909, in addition to designing and installing isolated power plants, he was responsible for the electrification of many glass plants which increased the efficiency and lowered the costs of production. These years covered the period in which he was associated with the Gee Electric Company of Wheeling, West Virginia.

From 1909 to 1919, Mr. Frazier was employed as chief engineer of the Hazel-Atlas Glass Company. During this time, the change over from the semiautomatic to the completely automatic method of producing glass was made. Many labor-saving pieces of equipment were designed and installed by him, not only for handling raw materials but also for moving the finished products.

From 1919 to the present date, he has been engaged in the design and building of complete glass plants, furnaces (tanks), and annealing equipment (lehrs), not only for the container and tableware industries but also for the plate- and window-glass manufacturers.

In 1919, he assumed the presidency of the Simplex Engineering Company, engineering specialists to the glass industry. This name in 1937 was changed to Frazier-Simplex, Incorporated. As head of this Corporation, he directed the installation of the first Fourcault window-glass plant in the United States.

The Simplex Company was the first organization to design producer-gas plants, reducing lost time caused by burn-out operations. This Company was also the first to install producer-gas plants to completely eliminate burn-out periods, which made it possible to operate a Fourcault window-glass plant continuously without additional fuel other than the prime fuel, producer gas.

Under Mr. Frazier's supervision, the first electric-heated, roller-type lehr for plate glass was designed, installed, and used in conjunction with the Bicheroux process. By this process it was possible to anneal glass sheets without handling or transferring them between the casting machine and the lehr, thereby improving the quality of the glass so that the net production was greater than with the former methods. This also increased the capacity of the Bicheroux process because the glass could be cast thinner, which gave more square feet of glass per pot and resulted in lowering the grinding costs.

Frazier-Simplex, Incorporated, under Mr. Frazier's direction, introduced the use of exhaust steam for the saturation of full mechanical producers in the glass industry, using the prime mover as a reducing valve, which increased the over-all efficiency of the producer plant.

This Company was also the first to install the suspended back wall and covered doghouse used in conjunction with mechanical batch feeders, which resulted in the improvement in furnace (tank) operation.

Under Mr. Frazier's direction, the first electric low-heat, woven-wire mesh conveyer and annealing and decorating lehr was designed, as well as the first recirculating low-heat type lehr.

A number of patents have been issued to Mr. Frazier, involving improvements in glass manufacturing.

Mr. Frazier is a Fellow of The American Ceramic Society and of the Society of Glass Technology of England. He is a member of the National Society of Professional Engineers, being registered in New York and Pennsylvania; The Pennsylvania Society of New York City; The Chamber of Commerce of Washington; and the Washington Golf and Country Club.

His name appears in The First Biographical Encyclopedia of the World; in Who's Who in Pennsylvania; and in Pittsburgh's Blue Book. He married Mary Ellen Gibson of Tarentum, Pennsylvania. They have two sons and three daughters, John Earl, Chauncey T., Helen Marie, Gladys E., and Dorothy O. His residence is at 417 East Beau Street, and his business address is 436 East Beau Street, Washington, Pennsylvania.

ACTIVITIES OF THE SOCIETY

NOMINATIONS FOR SOCIETY OFFICERS, 1941–1942

The American Ceramic Society Nominating Committees A and B have submitted the following names for the offices of president, vice-president, and treasurer, for the year 1941–1942.

For President: J. T. LITTLETON, Corning Glass Works, Corning, N. Y. (for photograph and biographical sketch, see *The Bulletin*, **19** [5] 182–84 (1940))

For Vice-President:

PERRY D. HELSER, White Plains, N. Y.

EDWARD SCHRAMM, Onondaga Pottery Co., Syracuse, N. Y.

For Treasurer: C. FORREST TEFFT, Claycraft Co., Columbus, Ohio

Glass Division Trustee, 1941–1944

The Nominating Committee of the Glass Division has submitted the name of G. W. Morey, Geophysical Laboratory, Washington, D. C., for the office of Trustee of the Glass Division for the term 1941–1944.

PERRY D. HELSER

Perry D. Helser, who has been a member of The American Ceramic Society since 1917, was elected to Fellowship in The Society in 1931. He was elected to the presidency of the General Ceramics Company, New York, N. Y., in December, 1939, and he resigned from this position in December, 1940.

Mr. Helser was born November 24, 1893, on a farm near Thornville, Perry County, Ohio. Following graduation from the Thornville High School in June, 1912, he taught grade school at Linnville, Ohio, for a year. In 1917, he received the degree of Bachelor of Science in Ceramic Engineering from Ohio State University. While attending the University, he was a member of the Student Branch of The American Ceramic Society, chairman of this group in his senior year, and elected to Sigma Xi.

Mr. Helser has held the following positions since 1917: 1917–1918, production control, Mosaic Tile Co., Zanesville, Ohio; 1918–1919, lieutenant, Chemical Warfare Service, U. S. Army, Edgewood Arsenal, Edgewood, Md.; 1919–1924, development work, A C Spark Plug Co. and the Flint Faience & Tile Co., Flint, Mich.; 1924–1925, ceramic engineer, U. S. Bureau of Mines, Columbus, Ohio; 1925–1927, development and production control, the R. Thomas & Sons Co., Lisbon, Ohio; 1927–1931, vice-president, Eljer Co., Ford City, Pa.; and 1931–1940, executive offices with General Ceramics Co.

He has been affiliated principally with the White Wares Division of The Society, being chairman of the Membership Committee, 1929–1931, and Trustee from 1935–1938. He was also Chairman of the Pittsburgh Section in 1930, appointed representative of The Society on the American Standards Association Sectional Committee on Minimum Requirements for Plumbing and Standardization of Plumbing Equipment A–40 in 1936, a member of the Finance Committee of The Society in 1936–1937, and chairman of the Vitreous China Plumbing Fixtures Association, 1940.

Mr. Helser is a member in New York of the Rotary Club (first vice-president); the Advertising Club; the Ohio Society; and the Ohio State Alumni Group.

Two papers by Mr. Helser have been published in the *Journal of The American Ceramic Society*.

(With S. J. McDowell) "Data on Operation of a Continuous Tunnel Kiln at the Plant of the A C Spark Plug Company," **5** [6] 267–75 (1922).

"A Laboratory Load Furnace," **8** [12] 822–25 (1925).

Perry D. Helser, Nominee for Vice-President of The Society.

EDWARD SCHRAMM

Edward Schramm is one of the nominees for the office of vice-president of The American Ceramic Society for the year 1941–1942. At the present time, Dr. Schramm is serving as Dean of Fellows.

Dr. Schramm was born December 22, 1886, in New York, N. Y. Following his graduation from the City College in New York City, he attended Columbia University, where he received a degree in Chemical Engineering in 1909 and the Ph.D. degree in 1913. In 1935, Dr. Schramm received the Professional Degree in Ceramic Engineering from the New York State College of Ceramics, Alfred University, Alfred, N. Y.

From 1909 to 1911, he was chemist and metallurgist with the American Locomotive Company; from 1913 to 1917, assistant chemist, Bureau of Standards, Washington, D. C.; from 1917 to 1919, in charge of the Research Department, American Zinc, Lead, and Smelting Company; from 1919 to 1920, physical chemist, Bridgeport Brass Company; and from 1920 to the present time, chief chemist, Onondaga Pottery Company, Syracuse, N. Y.

Contributions to the Ceramic Industry

The Onondaga Pottery Company had earlier achieved a position of leadership in the ceramic industry, which has been successfully maintained during the period of Dr. Schramm's service. New developments have included (1) the development of colored bodies, ivory and buff;

(2) the study of glazes embracing control of application, firing methods, adaptability to underglaze colors, and physical properties of the finished product; and (3) processes for solid color decoration and the application of new underglaze colors. In addition to the foregoing product developments, Dr. Schramm has contributed to process control and to the study of ceramic materials, in which fields a number of publications have appeared in the *Journal of The American Ceramic Society*. Under the leadership of R. H. Pass, vice-president of the Onondaga Pottery Company, a study of the dust problem was carried out some years before general public appreciation of the importance of this phase of industrial hygiene. Dr. Schramm conducted probably the first complete survey of dust conditions in a ceramic plant in this country, and he demonstrated the possibility of establishing control. Other activities have concerned relations to the public, particularly educational efforts through the publication of pamphlets and by means of lectures to bring about appreciation of the properties of ceramic products and of the best conditions for maintenance.

Edward Schramm, Nominee for Vice-President of The Society.

Activities

Dr. Schramm became an Associate Member of The American Ceramic Society in 1920 and was admitted to active membership in 1923. He was Trustee of the White Wares Division from 1928 to 1931, Chairman of the Division in 1935, and a member of the Nominating Committee in 1936. He has served for a number of years on the White Wares Division Research Committee, on the Research Committee of the United States Potters' Association, and on the Advisory Committee to the National Bureau of Standards. He was one of the charter members of the Fellows, and he has been actively interested in the Ceramic Association of New York since its formation, serving as president of that organization during the year 1939–1940.

Dr. Schramm is a member of Phi Beta Kappa and Sigma Xi.

Publications

"Method for Refining Iron Electrolytically," *Jour. Ind. Eng. Chem.*, 1910.

"Surface Tension of Molten Hydrated Salts," *Jour. Amer. Chem. Soc.*, 1913.

"Test of a Surface Combustion Furnace," *Jour. Ind. Eng. Chem.*, 1914.

"Preparation of Pure Iron and Iron-Carbon Alloys," *Bur. Stand. Jour. Research Sci. Paper*, No. 266, 1916.

"Determination of Cd by Hydrogen Sulphide Method," *Jour. Ind. Eng. Chem.*, 1919.

"Device for Testing Resistance of China to Chipping," *Jour. Amer. Ceram. Soc.*, **5** [3] 136–39 (1922).

"Properties of Clays and Clay-Grog Bodies," *ibid.*, **7** [4] 282–84 (1924).

"Determination of Porosity of China by Water-Soaking Method," *ibid.*, [6] 444–46.

(With E. W. Scripture, Jr.) "Particle Analysis of Clays by Sedimentation," *ibid.*, **8** [4] 243–52 (1925).

(With E. W. Scripture, Jr.) "Deflocculation of Clay Slips and Related Properties," *ibid.*, **9** [4] 175–84 (1926).

"Effect of Potash and Soda Feldspar in China Body," *ibid.*, **10** [12] 1005–1006 (1927).

(With E. W. Scripture, Jr.) "Particle Size Distribution of Typical Feldspars and Flints," *ibid.*, [4] 264–67.

"Sandblast Abrasion Test for Glazes," *ibid.*, **12** [5] 356–59 (1929).

(With R. F. Sherwood) "Properties of Glaze Slips," *ibid.*, [4] 270–73.

(With F. P. Hall) "Impact Properties of China," *ibid.*, **13** [12] 915–22 (1930).

"Dust Elimination in Pottery Industry," *ibid.*, **16** [5] 205–13 (1933).

(With F. P. Hall), "Notes on Casting Slip," *ibid.*, **17** [9] 262–67 (1934).

(With F. P. Hall) "Fluxing Effect of Feldspar in Whiteware Bodies," *ibid.*, **19** [6] 159–68 (1936).

"Care of China," *Bull. Amer. Ceram. Soc.*, **15** [2] 66–68 (1936).

"Problems in Whiteware Glazes," *ibid.*, **17** [11] 436–40 (1938).

HONORARY MEMBERSHIP

The Committee on Honorary Membership requests suggestions from members of The American Ceramic Society. If you have someone in mind who should be considered as an Honorary Member, send accurate information covering the following points to the Chairman of the Committee:

(1) Full name and address.
(2) Date and place of birth.
(3) Names of parents with scientific and cultural background.
(4) Education, with institutions attended and degrees obtained (with dates).
(5) Positions held, with titles and dates.
(6) List of publications with full titles and specific journal references.
(7) Membership in scientific societies.
(8) Honors received.
(9) Information concerning wife and children (if individual is married).
(10) Recent photograph of nominee.
(11) Your personal letter of recommendation.

The Committee on Honorary Membership is as follows:

ALEXANDER SILVERMAN, *Chairman;* Dept. of Chemistry, Univ. of Pittsburgh, Pittsburgh, Pa.
M. E. HOLMES: New York State College of Ceramics, Alfred, N. Y.
LOUIS NAVIAS: General Electric Co., Schenectady, N. Y.
R. F. GELLER: National Bureau of Standards, Washington, D. C.

RUGGED INDIVIDUALS EXTROVERT THEIR ACTS AND THOUGHTS

They Are Unselfish

Cooperative Enterprises Were Founded by and Continue to Be Effective by Those Who Extrovert Their Acts and Thoughts

HERE IS THE NEW SCORE SHEET OF THE AMERICAN CERAMIC SOCIETY EXTROVERTS

Those Rugged Individuals Who Value a Rugged Society

Paid Membership Record to November 19, 1940

Date of Record	Members Paid		Deferred	Subscriptions	Monthly Sales	Total Circulation
	Personal	Corporation				
December 22, 1937	1713	220	12	523	220	2688
December 19, 1938	1815	222	26	589	220	2872
December 19, 1939	1876	237	27	642	220	3002
January 22, 1940	1930	244	23	656	220	3073
February 20, 1940	1972	243	30	669	220	3134
April 17, 1940	1724	241	30	522	220	2737
May 21, 1940	1801	247	27	552	220	2847
June 19, 1940	1839	251	28	556	220	2894
July 18, 1940	1870	254	32	561	220	2937
August 19, 1940	1885	254	31	565	220	2955
September 19, 1940	1892	255	28	572	220	2967
October 21, 1940	1910	256	27	569	220	2982
November 19, 1940	1950	259	26	567	220	3022

ROSTER CHANGES*

During October

HELZ, ARMIN W., Box 5, Milltown, N. J. (Columbus, Ohio)
HUNTER, CHARLES E., Box 535, Knoxville, Tenn. (Norris, Tenn.)
LONGENECKER, H. L., 40 Home St., Metuchen, N. J. (Perth Amboy, N. J.)
ROUP, ROLLAND, 3827 North 6th St., Milwaukee, Wis. (Pittsburgh, Pa.)
STEVENS, DOUGLAS F., 1210 W. California St., Urbana, Ill. (Danville, Ill.)

During November

ANWYL, R. H., Harlem Farm Brick Plant, Sugarland, Texas (Richmond, Texas)
BREEZE, LEWIS K., 1996 Iuka Ave., Columbus, Ohio (Champaign, Ill.)
CONNER, HARVEY, Brick Manufacturers Association of New York, Inc., 26 Ferry St., Kingston, N. Y. (New York, N. Y.)
CRAWFORD, GEORGE E., 406 Belmont Ave., Haddonfield, N. J. (Kittanning, Pa.)
CUMMINS, ARTHUR B., Valley Rd., Millington, N. J. (Plainfield, N. J.)
DORN, ALVAH J., Allegany, N. Y. (Olean, N. Y.)
DUPLIN, VICTOR J., JR., 300 North Ave., Fanwood, N. J. (Lynbrook, L. I., N. Y.)
FAUST, GEORGE T., Sunnyside Rd., Berwyn, Md. (Tuscaloosa, Ala.)
GITTER, A. JOSEPHINE, Ceramic Workshop, Dennison Ohio (Zanesville, Ohio)
HALL, JAMES L., Metallurgical Labs., American Brake Shoe & Foundry Co., Mahwah, N. J. (Cambridge, Mass.)
LAIRD, STANLEY M., Box 413, Salem, N. J. (Pittsburgh, Pa.)
LIN, CHO-YUAN, 5005 Woolworth Bldg., New York, N. Y. (Mexico, Mo.)
REINKER, GERALD E., Bridgeville Glass Works, General Electric Co., Bridgeville, Pa. (Niles, Ohio)
SCHLEHR, W. RAYMOND, Central Y.M.C.A., Baltimore, Md. (Linthicum, Md.)

* Address in parentheses is former address.

NEW MEMBERS FOR NOVEMBER

Corporation

AMERICAN GLASS CORP., Greensburg, Pa.

Personal

BAER, F. L., 1130 Pine Ave., West, Montreal, Quebec, Canada.
BRYCE, G. S., Bryce Brothers Co., Mount Pleasant, Pa.; president.
CASAMO, CHARLES C., 32 West 4th St., Emporium, Pa.; glass technologist, Hygrade Sylvania Corp.
CHIEH, CHEN, Chinese ambassador, Berlin, Germany.
DORSETT, O. A., Knox Porcelain Corp., Knoxville, Tenn.; president.
*EILERT, CHARLES W., Minnesink Park, Red Bank, N. J.; chief ceramist, C. Pardee Works.
FALCONER, ROBERT F., Box 38, El Segundo, Calif.; secretary and treasurer, General Tile Corp.
*HENRY, KENNETH M., Kimble Glass Co., Vineland, N. J.; chief engineer.
*HOPKINS, ROBERT W., 2444 Sanford Ave., Alton, Ill.; ceramic engineer, Owens-Illinois Glass Co.
HOUGHTON, AMORY, The Knoll, Corning, N. Y.; president, Corning Glass Works.
IRWIN, WILLIAM W., Potters Supply Co., East Liverpool, Ohio.
JACKSON, L. P., 2189 Beaufait St., Detroit, Mich.; engineer, Mid-West Abrasive Co.
JEFFREY, G. H., 174 High St., Metuchen, N. J.; ceramic engineer, National Fireproofing Corp.
KENYON, MARTHA E., 2672 N. Moreland Blvd., Cleveland, Ohio; art teacher, James Ford Rhodes Senior High.
LITTRELL, LAWRENCE W., Piney River, Va.; chief chemist, Dominion Minerals, Inc.
MILNER, EDWIN E., R.R. 2, Muncie, Ind.; chief engineer, Ball Brothers Co.
ORTMAN, ROBERT A., 1500 1st Ave., South, Seattle, Wash.; salesman, Gladding, McBean & Co.
PETRIE, LLOYD R., 404 W. Snyder St., Abingdon, Ill.; ceramist, Abingdon Sanitary Mfg. Co.
*PFEIFF, C. H., Box 527, Metuchen, N. J.; president, Curran-Pfeiff Corp.
READ, CHARLES W., 205 Hazelcroft Ave., New Castle, Pa.; vice-president and sales manager, Shenango Pottery Co.
SPENGLER, H. H., Mahoning Glass Works, Niles, Ohio; engineer.
THOMAS, LAWRENCE E., 413 Highland Ave., Kittanning, Pa.; vice-president and treasurer, Eljer Co.
THOMPSON, GEORGE C., East Liverpool, Ohio.
UTECHT, NORMAN R., Olean Glass Co., Olean, N. Y.; assistant superintendent.
VANICK, JAMES S., International Nickel Co., Inc., 67 Wall St., New York, N. Y.; metallurgist.
WISELY, JOHN H., Art Institute, Kansas City, Mo.; artist, WPA.
*YOUNG, VINCENT M., 41 Walbert Dr., Rochester, N. Y.; glass technologist and foreman, Bausch & Lomb Optical Co.

Student

Missouri School of Mines: HAROLD B. BUTE.
Ohio State University: WILLIAM G. COOPER and LAWRENCE D. HOWER, JR.
Pennsylvania State College: MICHAEL P. FEDOCK and JACK E. MORGAN.

* Former member of The Society rejoining.

MEMBERSHIP WORKERS' RECORD

Corporation

Donald Hagar	1

Personal

A. A. Ayars	1	J. C. Hostetter	1
Donald Hagar	22	S. R. Scholes	1
P. G. Herold	1	Office	1

Student

E. C. Henry	2	A. S. Watts	2
	P. G. Herold	1	
		Grand Total	**33**

INSTITUTE OF CERAMIC ENGINEERS

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Vice-President: E. H. FRITZ, Westinghouse Electric & Mfg. Co., Derry, Pa.
Secretary: H. M. KRANER, Bethlehem Steel Co., Bethlehem, Pa.
Past-President: J. L. CARRUTHERS, Ohio State Univ., Columbus, Ohio.
Trustee Representative: R. E. BIRCH, Harbison-Walker Refractories Co., Pittsburgh, Pa.

Note for Associate Members

Many who applied for Member Grade before May, 1940, were admitted only to Associate Membership owing to the

failure of the original Rules to provide a wholly workable system for judging professional experience. This deficiency was eliminated by the Rules which were adopted by the Institute at Toronto. All Associate Members, who initially applied for Member Grade, should now apply to Arthur S. Watts, Chairman of the Membership and Examinations Committee, for promotion if they believe that they are qualified for Member Grade according to the adopted changes in the Rules of the Institute. The applicant's record will be examined promptly by the new procedure, which was published in the May, 1940, *Bulletin*, p. 197.

Urbana Meeting with A.I.M.M.E.

The Institute cooperated with the Industrial Minerals Division of the American Institute of Mining and Metallurgical Engineers in arranging the program for the Illinois Mineral Industries Conference held at Urbana, November 14 to 16, 1940. One of the purposes of this meeting was the dedication of the new State Natural Resources Building (see *The Bulletin*, November, pp. 457–58). One entire session was devoted to Clay and Ceramic Products.

This is the second consecutive year in which the Institute and the A.I.M.M.E. have worked together in developing a program of ceramic interest. The 1939 meeting was held at Tuscaloosa, Ala.

Report on Annual Meeting of National Council of State Boards of Engineering Examiners

The work of the Council at this meeting, which was held at Charleston, S. C., October 28 to 30, 1940, was more or less routine, being devoted largely to standardizing the requirements for registration in the various states.

The representative of the Institute was interested in persuading the state boards of New Jersey, Virginia, West Virginia, and Texas to recognize ceramic engineering. Owing to lack of appropriations, however, New Jersey and Texas had no representatives present.

The Virginia Board agreed to recognize ceramic engineers, but felt that, under the law, it would have to classify them as "Ceramic Mining Engineers." The West Virginia Board is friendly, but it does not believe that ceramic engineers in the State are interested in registration as they have made no demand for it. The Institute will have to encourage the ceramic engineers of West Virginia to apply for registration in order to make progress.

The Maryland Board advised it is examining the applications as rapidly as possible and has already passed about 700 applicants. It will probably take two years to examine the applications on file. The Board intimated that the ceramic engineers who had made application had nothing to worry about.

Bills providing for registration of engineers will be presented to the next legislatures in Illinois, Missouri, and Montana, which will complete the roll of the states. The Institute, of course, should make every effort to have ceramic engineers classified in Missouri and Illinois.

The Council again urged the national societies to have the members of their student branches instructed in the desirability of and requirements for professional registration in order to raise the professional status of engineers to the level of the medical and legal professions. There are now 68,000 registered engineers in the country.

Every national engineering society was represented at the meeting.

—Submitted by A. F. GREAVES-WALKER, *Chairman*,
Institute Committee on State Boards of
Engineering Examiners

Texas Board of Registration Recognizes Ceramic Engineer

The Texas Board of Registration for Professional Engineers has recognized the ceramic engineer and has issued to Robert H. Anwyl the first license as a professional engineer in the State. Mr. Anwyl is superintendent of the Harlem Farm Brick Plant of the Texas Prison System, located at Sugarland, Texas.

Mrs. L. C. (Ruth) Roche, Chairman, Ladies' Committee, Forty-Third Annual Meeting, Lord Baltimore Hotel

BALTIMORE-WASHINGTON SECTION

The Baltimore-Washington Section held a dinner meeting at the Arts Club of Washington, Washington, D. C., Saturday, November 16, 1940. About forty members and guests attended.

J. W. McBurney, a member of the Bureau of Standards staff, spoke on "Stones, Semiprecious and Otherwise." Ceramists are familiar with names such as feldspar, quartz, corundum, olivine, and beryl. Mr. McBurney discussed moonstones, amethysts, rubies, peridots, emeralds, and aquamarines, which are the jeweler's names for these ceramic minerals. Thirty trays of Mr. McBurney's collection of typical rough and cut specimens were passed among the audience for close examination.

—DWIGHT G. MOORE, *Secretary-Treasurer*

UNIVERSITY OF WASHINGTON

The autumn quarter at the University of Washington has witnessed the coming of many new faces, and encouragingly enough, the people in the Northwest are becoming more and more conscious of ceramics. Greater appreciation of the contributions of this industry to modern living is being more fully realized as each year advances.

Many new additions and changes have been made in the laboratories at the University, chief of which is the purchase of a Smith alloy electric furnace for testing enameled glazes and a pH meter for testing clays. The senior thesis work this fall is covering a wide range of interest, for example, talc, glass sand, refractories, and glazes.

Two bi-monthly meetings of the Student Society have been held. Dean Milnor Roberts spoke on publications of in erest to the students, and Wendell Keith described his experiences of the summer.

Of interest to many has been the exceptionally fine exhibit of Chinese pottery at the Volunteer Park Art Museum in Seattle. Most noteworthy in the exhibit were

many rare pieces from the Sung and Ming dynasties. Several beautiful pieces of celadon were also on exhibit to the public.

Two fellowship students are working for their Master's degrees, the problems being the development of Pacific Northwest diatomite and olivine for commercial uses.

During the summer, a field trip was conducted into the Cascade Mountains for the purpose of securing ample specimens to carry on these projects.

Annual Mining Institute, 1941

College of Mines, University of Washington

The Fourteenth Annual Mining Institute will be held during the week of January 20–25, 1941. The attendance in 1940 was 325. Meetings are scheduled on the University campus each day, including a field trip to some plant of mining or metallurgical interest. Members of the College of Mines staff will give lectures or laboratory demonstrations covering the fields of mining, metallurgy, and ceramics. New equipment and machinery will be exhibited, motion pictures of current operations will be shown, and operators and engineers will describe and illustrate the activities in their fields.

Sessions are open without charge to all interested persons. The carefully prepared schedule permits attendance at a single meeting or a series of meetings during the session. Requests for information should be addressed to Milnor Roberts, Dean, College of Mines, University of Washington, Seattle, Washington.

—James F. McKinnell

RUTGERS UNIVERSITY

The Rutgers Ceramic Club and Student Branch of The American Ceramic Society held the first meeting of the academic year, 1940–1941, on October 11, in the Assembly Room of the Ceramics Building at Rutgers. This meeting was of a social nature at which twenty-six freshman members were initiated into the Club and given the opportunity to become acquainted with the upperclassmen and faculty members of the Department. An enjoyable evening was spent in playing games and singing college songs. Refreshments were served.

The Club's program for this year includes several lectures by outstanding men in the field of ceramics. The third meeting of the Club was held on November 18. An interesting talk on "Control Testing in Whiteware Manufacture" was given by Roland V. Tailby, of the Architectural Tiling Co., Keyport, N. J.

Officers, 1940–1941

The officers are *President*, Robert I. Owen (1941); *Vice-President*, William H. Bauer (1942); *Secretary*, Malcolm A. Schweiker, Jr. (1943); *Corresponding Secretary*, Joseph V. Lazo(1942); and *Treasurer*, Robert L. Buttle (1941).

MISSOURI SCHOOL OF MINES AND METALLURGY

The Student Branch of The American Ceramic Society at the Missouri School of Mines and Metallurgy met on October 30. After a short business session, William K. Schweickhardt, salesman with the Walsh Refractories Company of St. Louis, talked on "Qualifications of a Ceramic Salesman." Mr. Schweickhardt, one of the first graduates from the Missouri School of Mines Ceramic Department, pointed out that the life of a salesman is not just one party after another, with an occasional call to prospective buyers. A salesman must make many calls during the ordinary working day, using a different angle of attack on each customer. He must then drive to the next town, make out his reports, and perhaps entertain another prospect that night (which may turn out to be work if the prospect likes a type of entertainment differing from the salesman's ideas).

The members showed a lively interest in the examples of refractories manufactured by the Walsh Company which were exhibited and explained.

—Paul G Herold, *Ceramic Engineering Department*

NECROLOGY

CHARLES LUCIUS ALLEN*

Charles L. Allen, chairman of the board of Norton Company and its general manager for forty-eight years until his retirement from that post in 1933, died of bronchial pneumonia on November 4, 1940, at his home in Worcester, Mass.

He was born in Worcester on March 6, 1858, the son of George Lucius and Eliza Jane (Black) Allen. He attended the Worcester schools and was graduated from the old Worcester High School in 1876.

Until 1879 he continued as a clerk in a shoe store, resigning to become a clerk in the Worcester office of the Boston & Maine Railroad.

Mr. Allen had started with the F. B. Norton Company as a bookkeeper in 1881 when it was a struggling pottery shop on Water Street, employing thirteen men where an experiment in making a grinding wheel eventually led to the establishment of the vast factory. The Norton Emery Wheel Company was organized in 1885, and Mr. Allen was made its general manager.

He became secretary and director of the Company in 1892 and in July, 1912, its treasurer, relinquishing the secretaryship. When the Norton Company, formerly Norton Emery Wheel Company, and the Norton Grinding Company were merged in 1919, Mr. Allen was elected president and general manager. When he retired from the administrative leadership of the Company in 1933, he became chairman of the board.

Editor's Note: For history of Norton Company, see *The Bulletin*, **15** [8] 295 (1936); for a biographical sketch of Mr. Allen, see *ibid.*, **17** [6] 266 (1938) (a photo of Mr. Allen appeared on the *Bulletin* cover).

* Excerpts from *The Evening Gazette*, November 4, 1940.

CONRAD DRESSLER

The Secretary of The Society received the following letter from Philip Dressler, son of Conrad Dressler, on November 13, the day that Mr. Dressler's paper on pottery was sent to the printer.

"I received your letter of November 11 this morning and almost at the same time I received the sad news that my father had died in France on August 3. This news came to me through the American Consul at Bordeaux, who is in charge of British affairs and to whom I had appealed for assistance in making contact with my father.

"While I have no details at all, I am convinced that my father is as much a victim of the war as those who have laid down their lives in the actual fighting. My father celebrated his eighty-fourth birthday on July 22 of this year. The last letter which I received from him was written on June 7, at which time the battle for Paris was in progress.

"I know that you, as well as his many other friends in this country, will be grieved to hear this news."

HOW I CAME TO TAKE AN INTEREST IN POTTERY

By Conrad Dressler

The methods of sculptors have undergone transforma-

tions which by no means have been favorable to the art in the course of the last few centuries. As a student of the work of the old masters, I soon became aware that there was a real decline in the value of modern work. I endeavored to discover the hidden cause of this fact, and I was not long in finding out that it arose, not from a lessening in talent among sculptors, but because the sculpture was no longer finished by the sculptor himself, but by a specialist employed by him, a carver who mechanically copied the plaster cast of a work modeled in clay by the sculptor.

Now it is absolutely impossible for any man other than the artist himself to render the feeling he has desired to put into his work, be it statue, bust, or medallion. This feeling is the whole merit of a work of art, and when it is absent, the loss in value is almost total.

What happens in modern times is that, owing to an insufficient appreciation on the part of the general public, for whom one statue is as good as another, the artist finds it to his interest to turn out as much work as possible, and therefore he calls in the assistance of the marble or stone carver.

In order to make this clear to the layman, let us consider how important in commercial transactions is a signature and how difficult, not to say impossible, it is to imitate it. A check for a big sum signed by Henry Ford or by J. D. Rockefeller will be honored without hesitation by any banker who is familiar with their signatures, whereas an imitation, however clever, would arouse suspicion. Yet if you compare two signatures of the same man you will discover important differences. It is therefore the personality of the signer which dominates and gives the signature its worth.

Again the Chromo is a marvelous facsimile of an original painting. Even the painting texture and the brush work are faithfully rendered, and as this is done photographically, there is the closest resemblance to the original. Yet what a difference in the value of the two when set side by side.

The pencil and chalk drawings of old masters are photographically reproduced in carbon and are marvelously close copies; but hold such carbon prints side by side with the original drawings and you will notice that something important has been missed.

All of these arguments led me to the conclusion that, for my part, I would not use the modern system. I tried hard to persuade members of the Art Workers Guild, of the Arts and Crafts, and later of the Royal Society of British Sculptors to adopt these views. But they were received with coldness. Progress was cited in favor of modern methods and only one or two sculptors sided with me. I must mention in particular Arthur Walker, who in his work preferred to do all of his own carving and therefore condemned himself to slow production, hard work, and small profit. But his sculpture will live when the others will be forgotten.

If the work in clay has been modeled in such a way that it can be fired, we retain the original artist's touch, and this is what made me turn to pottery. I built a small kiln in my studio and in it fired statuettes, small groups, and sketches.

I made the acquaintance of a remarkable potter, William De Morgan, who designed beautiful vases and tile in the Persian style. His work was highly esteemed. He was good enough to fire some of my work and to put it on sale in a shop he had in Great Marlboro' Street, London.

I was approached about this time (1893) by Harold Rathbone, whose father, Philip Rathbone, was an enlightened supporter of arts in his native town of Liverpool, which he aimed at making the leading provincial art center. He suggested that I should launch an art pottery in his home city, where my own work could be carried out, fired, and used for local decorative purposes.

I fell in with his views, and with the help of a Staffordshire potter, we constructed a couple of muffles at Birkenhead, in which works of some size and importance could be fired.

I remained in Birkenhead for two years but found the commercial atmosphere of the place too trying to be able to remain longer. I executed a number of works there, however, among others the panels in Istrian stone on the face of St. George's Hall, busts of local celebrities, plaques and decorative panels, and a fountain in enameled pottery.

I felt the need of coming nearer to London and accepted an offer made me by R. W. Hudson to put up a little pottery at Medmenham in Buckinghamshire, some thirty miles west of London.

Here I executed, in enameled clay, an important frieze for the Sunlight Soap offices in Dublin. I followed closely along the lines of the Della Robbias, the great Italian artist potters of the fifteenth century. I also had an important commission through a Liverpool friend, Sir John Grey Hill, President of the Law Society, whose premises in London were in the course of being considerably added to by building a large central hall. I was asked to decorate this with panels symbolical of Justice tempered by Charity. This necessitated no less than a dozen figures, typifying the various virtues needed in both cases, and two large panels—in all some twenty figures, over life size and in high relief. It took me a year to execute this work.

The hall was opened by their Majesties, King Edward VII and Queen Alexandra, to whom I was presented. I also decorated the Humphrey Museum at Cambridge and the music room of Winchester College.

But because the sculptured work was not sufficient to keep my ovens filled, I thought out a new kind of wall tile, which became known as the Medmenham tile and commanded a good sale. These tile were subsequently taken up by the Arts and Pavements Company and became favorably known in the London market, where they displaced the ordinary commercial tile for the decorations of fireplaces, bathrooms, and such uses.

The burden of this industrial work, however, was too heavy for me and prevented me from attending to my sculpture. I longed to hand over that part of my task to others and was glad to find, in the Boothen Tile Works of Stoke-on-Trent, worthy continuators. These works were owned by Messrs. Dick, Boycott, and Sawyer, who became my friends and who later, in 1910, were the first to install my tunnel kiln, which is still being successfully operated. I have elsewhere given an account of how I came upon the invention of this tunnel kiln, and its developments. I do not wish to leave this account of my apprenticeship in pottery without the mention of my friends, M. Achille Parvillée and M. Thomas, French potters, to whom I owe

a debt of gratitude for all they taught me in this wonderful and complex art.

Editor's Note: See "Dressler Tunnel Kilns' Genesis," by Conrad Dressler, *The Bulletin*, **14** [6] 216–17 (1935). For biographical sketch and photograph of Mr. Dressler, see *ibid.*, **3** [1] 17–18 (1924).

TESTIMONIAL DINNER FOR R. R. SHIVELY

Friends of R. R. Shively of Washington, Pa., entertained with a testimonial dinner at the George Washington Hotel on the evening of October 29, 1940. About fifty persons attended the party. Francis C. Flint, of the Hazel-Atlas Glass Company, served as toastmaster and E. E. Tillotson gave an outline of the accomplishments of Dr. Shively and presented him with a Fellow key of The American Ceramic Society. R. C. Purdy, Secretary of The Society, was present and gave a brief talk on the work being accomplished by this organization. J. Earl Frazier, of Frazier-Simplex, Inc., was active in organizing the testimonial dinner.

Dr. Shively, who is chief technologist with the B. F. Drakenfeld Company, has been a member of The American Ceramic Society since 1919, and he was elected to the group of Fellows in 1940.

Guests at Shively Dinner

UNITED STATES POTTERS ASSOCIATION

The annual meeting of the United States Potters Association was held at the Hotel Hollenden, Cleveland, Ohio, December 3 and 4, 1940. Charles F. Goodwin is Secretary-Treasurer of the Association.

CENTRAL DISTRICT ENAMELERS' CLUB

The Central District Enamelers' Club held its first meeting of the 1940–1941 season on Friday, November 29, at the Allerton Hotel, Cleveland, Ohio.

After dinner, the following program was presented:

(1) "Unusual Service Problems" by J. E. HANSEN, Ferro Enamel Corp., Cleveland, Ohio.

(2) "Light Distribution in Inspection Booth Setups for Color Matching" by A. K. GAETJENS, General Electric Co., Nela Park. —G. E. PFLEGER, *Secretary-Treasurer*

GRINDING WHEEL MANUFACTURERS AND ABRASIVE GRAIN ASSOCIATIONS

A joint meeting of the Wheel and Grain Associations was held at the Hotel Claridge, Atlantic City, N. J., December 4 and 5, 1940. On March 6 and 7, 1941, these Associations will hold a joint meeting at the Mid-Pines Club, Southern Pines, N. C. —HARRY B. LINDSAY, *Secretary-Treasurer*

NATIONAL PAVING BRICK ASSOCIATION

The Annual Meeting of the National Paving Brick Association will be held in Toledo, Ohio, Hotel Commodore Perry, January 15, 16, and 17, 1941.

THE AMERICAN CERAMIC SOCIETY

is organized cooperation *of*, *by*, and *for* ceramists.
Most ceramic firms and persons are progressive, clear thinkers
and would be supporting this SOCIETY, if and when solicited.

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The Vitro Mfg. Co.
Antimony Sulphide
Edgar Plastic Kaolin Co.
Foote Mineral Co.
The Hommel, O., Co., Inc.
Arches (Interlocking, Suspending, and Circular)
Frazier-Simplex, Inc.
Green, A. P., Fire Brick Co.
Arsenic
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Automatic Brick Car Loaders
Lancaster Iron Works, Inc.
Ball Mills
Ceramic Color & Chemical Mfg. Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
McDanel Refractory Porcelain Co.
The Vitro Mfg. Co.
Ball Mills (Laboratory Type)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Vitro Mfg. Co.
Barium Carbonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Foote Mineral Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
The Vitro Mfg. Co.
Basic Oxides
Porcelain Enamel and Mfg. Co.
Batch Systems
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.
National Engineering Co.
Batts
Carborundum Co. (*"Carbofrax Aloxite"*)
Denver Fire Clay Co.
Norton Co. (*Alundum-Crystolon*)
Beryl
Foote Mineral Co.
Bichromate of Soda
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Bitstone
Potters Supply Co.
Blocks (Refractory)
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Green, A. P., Fire Brick Co.
Louthan Mfg. Co.
Norton Co.
The Vitro Mfg. Co.
Body Stains
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel, O., Co., Inc.
Bone Ash
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Borax
American Potash & Chemical Corp.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.
Borax Glass
American Potash & Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.
Boric Acid (Anhydrous)
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.
Boric Acid (Crystal, Granular, or Powder)
American Potash & Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.
Boron Carbide
Norton Co.
Brick Machines (also Barrows, Molds)
Lancaster Iron Works, Inc.
Brick (Refractory)
Carborundum Co. (*"Carbofrax Aloxite"*)
Cornart Refractories Co.
Denver Fire Clay Co.
Green, A. P., Fire Brick Co.
Norton Co.
The Vitro Mfg. Co.
Cadmium Sulphide
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Carbofrax (Refractory Products)
Carborundum Co.
Carbonates (Barium, Lead)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
The Vitro Mfg. Co.
Castings
Lancaster Iron Works, Inc.
Castings (Abrasive Resisting)
Bethlenem Steel Co.
Caustic Potash
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Solvay Sales Corp.
Caustic Soda
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Du Pont de Nemours, E. I., & Co., Inc. R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Pennsylvania Salt Mfg. Co.
Solvay Sales Corp.
The Vitro Mfg. Co.
Cements
Carborundum Co.
Corhart Refractories Co.
Green, A. P., Fire Brick Co.
Norton Co.
Pennsylvania Salt Mfg. Co.
Ceramic Chemicals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Metal & Thermit Corp.
Pennsylvania Salt Mfg. Co.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.
Cerium Oxide
Drakenfeld, B. F., & Co.
Foote Mineral Co.
Chromite (Natural Chromate of Iron)
Foote Mineral Co.
Chromium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.
Clay (Ball)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.
The Vitro Mfg. Co.
Clay (Bentonite)
Edgar Plastic Kaolin Co.
Great Lakes Foundry Sand Co.
Clay (Block)
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Clay (China)
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.
The Vitro Mfg. Co.
Clay—Cleaners, Feeders
Lancaster Iron Works, Inc.
Clay (Electrical, Porcelain)
Ceramic Color & Chemical Mfg. Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
The Hommel, O., Co., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.
Clay (Enamel)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Metal & Thermit Corp.
Paper Makers Importing Co.
Porcelain Enamel and Mfg. Co.
Spinks, H. C., Clay Co.

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HANDLING HEAT—

Melting Metal . . .

Resistance to high temperatures, chemical resistance toward oxides and low permeability toward molten metals—these are the features of Norton Cements and Bonded Shapes (Alundum, Crystolon and fused magnesia) that are reducing lining costs in many types of furnaces for melting ferrous and non-ferrous metals.

Sintering Metal . . .

Because they have high electrical resistance even at elevated temperatures, high refractoriness, high heat conductivity, high permeability and low coefficient of expansion, Alundum Tubes are showing outstanding performance in high temperature, wire wound electric resistance furnaces of all kinds—especially in the drawing and swaging of tungsten and molybdenum wire and sintering cemented carbides for tools.

Hardening Metal . . .

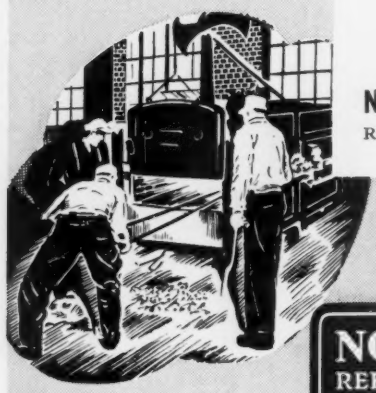
High refractoriness, great strength, high heat transfer, resistance to spalling and resistance to abrasion—these five features of Crystolon Hearth Plates and Crystolon Muffles are assuring long lining life and low fuel costs in heat treating furnaces of many types.

Enameling Metal . . .

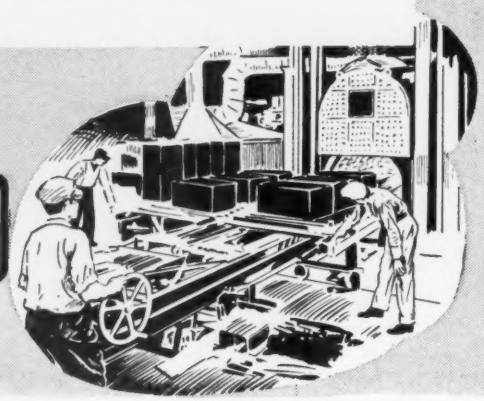
From the high refractoriness and chemical stability of Alundum Muffles for enameling furnaces comes their ability to give long, trouble-free service. From their high strength which allows plates of thin cross-section and their high heat conductivity comes their ability to cut fuel costs by passing heat quickly from source to work.

NORTON COMPANY, WORCESTER, MASS.

R-662A



NORTON
REFRACTORIES



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Edward Orton, Jr., gave his standard pyrometric cone business to the ceramic industries. The Foundation is supervised by representatives from the

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Los Angeles, Calif.

South American Representative
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4150 E. 56th St.
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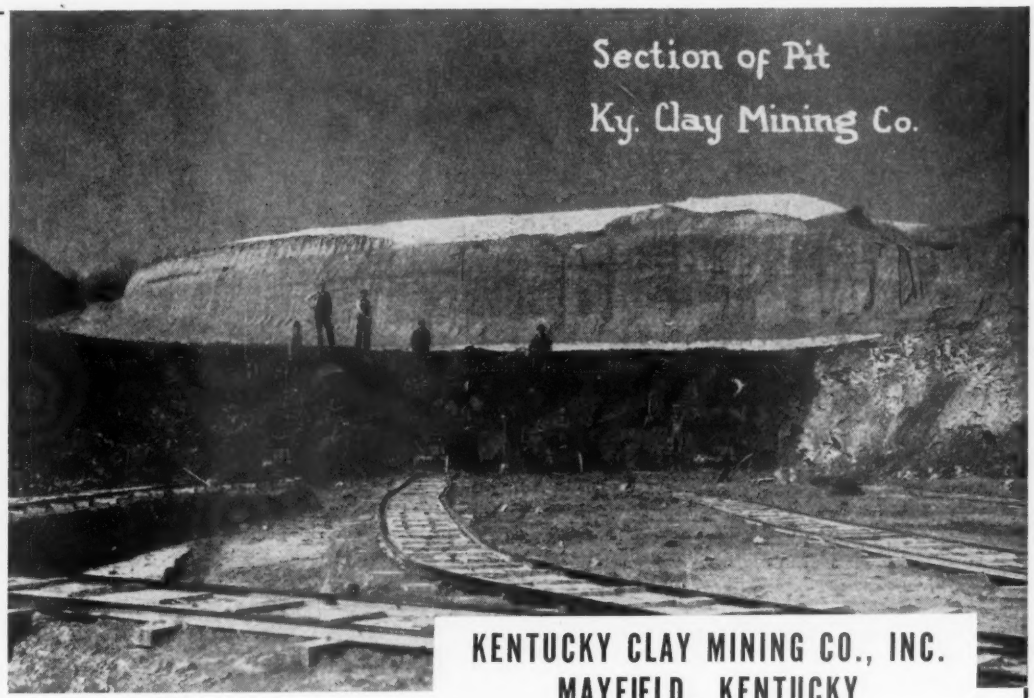
EDWARD ORTON, JR.
1893 - 1932

QUALITY BALL CLAYS



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MAYFIELD, KENTUCKY
V. J. Roehm, Alliance, Ohio

. . Produce Better Ware . .

Eastern Sales Representative
Enterprise White Clay Co.
Philadelphia, Pa.

Western Sales Representative
Mineral Products Company
Huntington Park, Calif.

BORAX *Guaranteed 99½%–100% Pure* **BORIC ACID**

Select the Brand which has back of it years of *successful use* by experienced Ceramists

Pacific Coast Borax Co., New York

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Tile for Decorating Kilns

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Imported Paris White
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Georgia Kaolin
Modeling Clay

THE POTTERS SUPPLY COMPANY
EAST LIVERPOOL, OHIO

for Permanent—Colorful

DECORATIVE LABELS on BOTTLES AND GLASS CONTAINERS

DU PONT
REG. U. S. PAT. OFF.

Resistant Colors
withstand Severe Service

IT TOOK years of extensive research to develop these Resistant Colors . . . to make certain that they met the severe service requirements for applied color labels on beverage bottles and other glass containers.

The present line of improved colors are now standard materials in most of the plants doing applied color label decorating because they are:

★ *Alkali-Resistant*—Repeated exposure to hot caustic solutions prove the superiority of these colors, their ability to stand up under drastic treatment.

★ *Acid-Resistant*—Extremely high—something once considered impossible to obtain jointly with high alkali resistance.

★ *Strain-Free*—Perfect matching of expansion coefficient with those of commercial bottle glass assures absence of strain or breakage troubles from these applied colors.

★ *Easily Applied*—Smooth, even color applications of exceptionally high gloss—easily adapted to the heaviest of multi-layer designs—can be obtained without the troubles usually associated with heavy applications.

No other colors can offer this combination of advantages which are so essential for the satisfactory performance of a decorated container. And with them is offered du Pont technical service, experienced men to assist in solving problems in applied color label decoration and in the working out of the most efficient production set-up possible for the individual shop. This service is offered you without obligation—we invite you to call on us.

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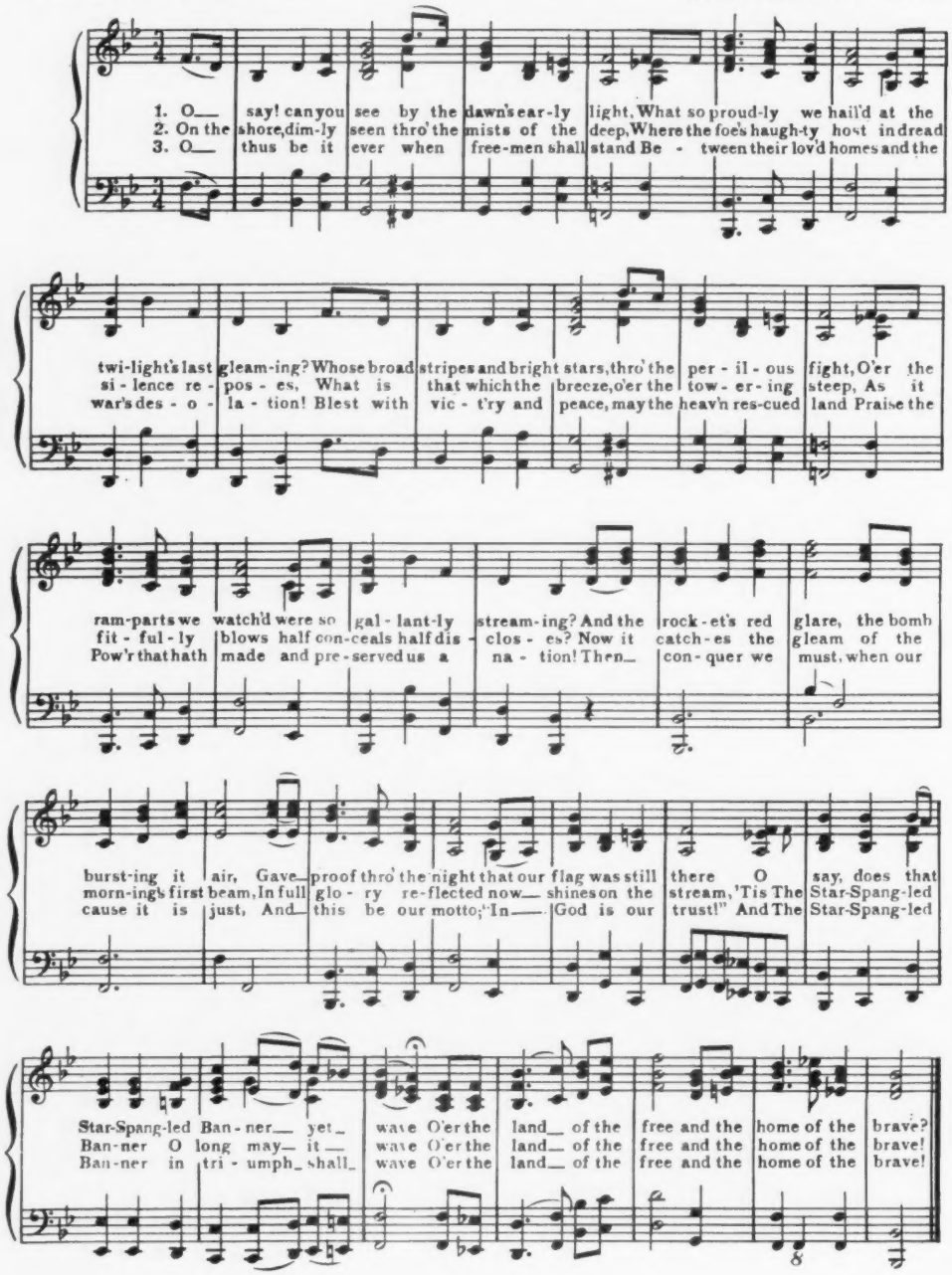
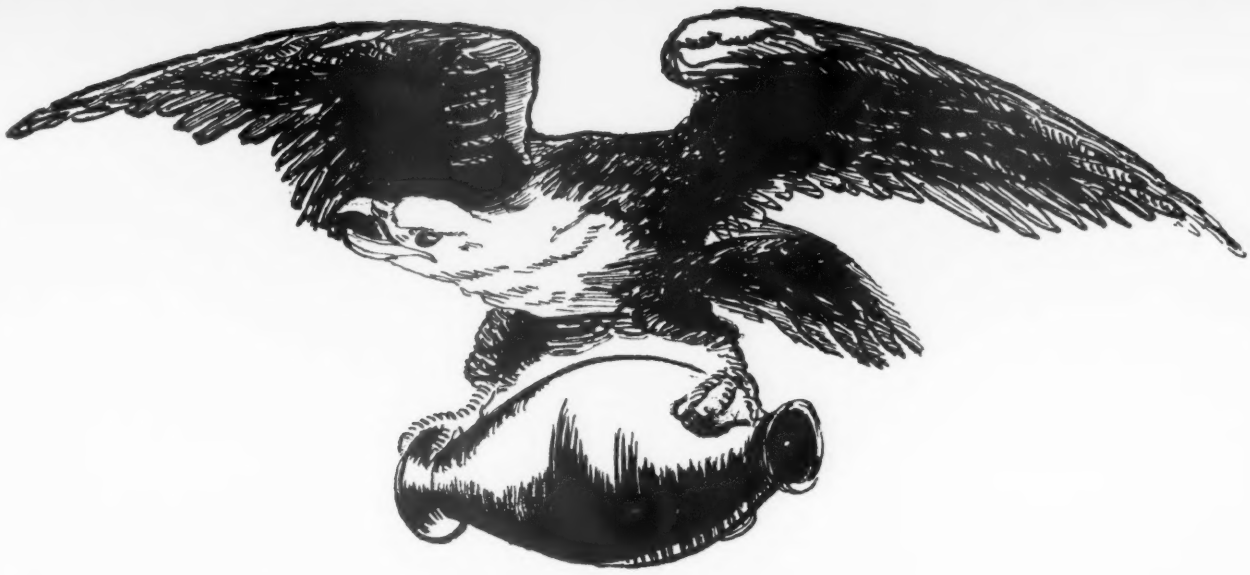
E. I. DU PONT DE NEMOURS & COMPANY (INC.)
The R. & H. Chemicals Department
Ceramics Division Wilmington, Delaware
District Sales Offices: Baltimore, Boston, Charlotte, Chicago, Cleveland, Kansas City, Newark, New York, Philadelphia, Pittsburgh, San Francisco

FORTY-THIRD ANNUAL MEETING OF THE AMERICAN CERAMIC SOCIETY

BALTIMORE, MARYLAND, MARCH 30 to APRIL 5, 1941

THE STAR-SPANGLED BANNER

FRANCIS SCOTT KEY — JOHN STAFFORD SMITH

1. O— say! can you see by the dawn's ear-ly light, What so proud-ly we hail'd at the
2. On the shore, dim-ly seen thro' the mists of the deep, Where the foe's haugh-ty host in dread
3. O— thus be it ever when free-men shall stand Be - tween their lov'd homes and the
twi-light's last gleam-ing? Whose broad stripes and bright stars, thro' the per - il - ous fight, O'er the
si - lence re - pos - es, What is that which the breeze, o'er the tow - er - ing steep, As it
war's des - o - la - tion! Blest with vic - t'ry and peace, may the heav'n res-cued land Praise the
ram-parts we watch'd were so gal - lant-ly stream-ing? And the rock-et's red glare, the bomb
fit - ful - ly blows half con-ceals half dis - clos - es? Now it catch-es the gleam of the
Pow'r that hath made and pre-served us a na - tion! Then— con - quer we must, when our
burst-ing it air, Gave— proof thro' the night that our flag was still there O say, does that
morn-ing's first beam, In full glo - ry re-flected now— shines on the stream, 'Tis The Star-Spang-led
cause it is just, And— this be our motto; "In— God is our trust!" And The Star-Spang-led
Star-Spang-led Ban - ner— yet— wave O'er the land— of the free and the home of the brave?
Ban-ner O long may— it— wave O'er the land— of the free and the home of the brave!
Ban-ner in tri - umph— shall— wave O'er the land— of the free and the home of the brave!



AMERICAN CERAMIC INDUSTRIES COME INTO THEIR OWN!

Of course, ceramics designed by Americans, made by Americans for Americans have always been the RIGHT answer to this hemisphere's ceramic requirements—But, in normal times, cargoes of imports flood our markets to be sold to a gullible public. They are bought on price and because we still have the old idea that foreign made products are better than our own...In times like these—when the spirit of Americanism is revived—when foreign imports have been cut off—our ceramic industry can come into its own...Design American—Sell America...We are back of you with a complete line of American made colors and chemicals for every ceramic process.

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Titanium Alloy & Mfg. Co.
United Clay Mines Corp.
The Vitro Mfg. Co.

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Denver Fire Clay Co.
Great Lakes Foundry Sand Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Potters Supply Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

Clay (German Vallendar)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Kentucky Clay Mining Co.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Clay (Micronized)
Porcelain Enamel and Mfg. Co.

Clay Miners
Edgar Plastic Kaolin Co.
Great Lakes Foundry Sand Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

Clay (Potters)
Denver Fire Clay Co.
Hammill & Gillespie, Inc.
The Hommel, O., Co., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

Clay (Process Equipment)
Lancaster Iron Works, Inc.
National Engineering Co.

Clay (Sagger)
Edgar Plastic Kaolin Co.
Great Lakes Foundry Sand Co.
The Hommel, O., Co., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

Clay-Slip (Albany)
Hammill & Gillespie, Inc.
United Clay Mines Corp.

Clay (Wad)
Kentucky Clay Mining Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
Thomas Albama Kaolin Co.
United Clay Mines Corp.

Clay (Wall Tile)
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

Cleaners
Pennsylvania Salt Mfg. Co.
Porcelain Enamel and Mfg. Co.

Cleaners, Chemical
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.

Clocks (Gauge Board)
The Hommel, O., Co., Inc.

Cobalt Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Cobalt Sulphate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.

Colors
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Cone Plaques
Industrial Ceramic Products, Inc.

Cones
Accurate Pyrometric Cone Co.
The Edward Orton, Jr., Ceramic Foundation

Conveying Equipment
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Lancaster Iron Works, Inc.
National Engineering Co.

Copper Oxide
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.

Corhart
Corhart Refractories Co.

Cornwall Stone (Imported)
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.

Crucibles (Filter, Melting, Ignition)
Carborundum Co.
Denver Fire Clay Co.
Norton Co.
Potters Supply Co.

Crushers (Clay)
Lancaster Iron Works, Inc.

Cryolite (see Kryolith)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Pennsylvania Salt Mfg. Co.
The Vitro Mfg. Co.

Crystolon (Refractory Products)
Norton Co.

Cullet, Washing Plants, Incinerators, Crushers
Frazier-Simplex, Inc.

Cutters (Bar)
Industrial Ceramic Products, Inc.

Decorating Supplies
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
The Vitro Mfg. Co.

Disintegrators
Lancaster Iron Works, Inc.
National Engineering Co.

Dryer (Pipe Rack)
Lancaster Iron Works, Inc.

Drying Machinery
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.
Proctor & Schwartz, Inc.

Electrocast Refractories
Corhart Refractories Co.

Enamelers' Borax
Porcelain Enamel and Mfg. Co.

Enameling Equipment (Complete)
Ceramic Color & Chemical Mfg. Co.
Frazier-Simplex, Inc.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Vitro Mfg. Co.

Enameling Furnaces
Carborundum Co.
Ceramic Color & Chemical Mfg. Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Lancaster Iron Works, Inc.
Norton Co.

Enameling Iron (Sheet)
American Rolling Mill Co.
Bethlehem Steel Co.

Enameling Muffles
Bethlehem Steel Co.
Carborundum Co. (*Carbofrax*)
Frazier-Simplex, Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co. (*Alundum*)

Enameling (Practical Service)
Ceramic Color & Chemical Mfg. Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Enamels
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Enamel Oxide
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Enamels (Porcelain)
Ceramic Color & Chemical Mfg. Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Equipment (Porcelain Enameling)
Ceramic Color & Chemical Mfg. Co.
The DeVilbiss Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.

Exhaust Systems
The DeVilbiss Co.

Feldspar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Filter Fabrics
Metakloth Company

Fire Brick
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Green, A. P., Fire Brick Co.
Norton Co.

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Great Lakes Foundry Sand Co.
Green, A. P., Fire Brick Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.

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Harshaw Chemical Co.
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Porcelain Enamel and Mfg. Co.

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Ingram-Richardson Mfg. Co. of Indiana, Inc.
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Norton Co.

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The Hommel, O., Co., Inc.

French Flint
Maxson, Elwyn L.
Paper Makers Importing Co.

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Ceramic Color & Chemical Mfg. Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
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Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
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Furnaces, Enameling
Swindell-Dressler Corp.

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Paper Makers Importing Co.

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Willson Products, Inc.

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Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
The Vitro Mfg. Co.

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Norton Co. (*Crystolon*)

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Norton Co.

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Harshaw Chemical Co.
The Hommel, O., Co., Inc.

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Harshaw Chemical Co.

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American Rolling Mill Co.
Bethlehem Steel Co.

Iron Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Kaolin
Ceramic Color & Chemical Mfg. Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.
The Vitro Mfg. Co.

Kilns, China (Decorating)
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Drakenfeld, B. F., & Co.
Frazier-Simplex, Inc.
The Hommel, O., Co., Inc.
Swindell-Dressler Corp.

Kilns-(Electric, Circular, Tunnel)
Swindell-Dressler Corp.

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Celo Mines, Inc.

Kryolith (see Cryolite)
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Foote Mineral Co.

Lithium Minerals
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Harshaw Chemical Co.
The Hommel, O., Co., Inc.
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Magnesite Calcined
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Harshaw Chemical Co.
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Harshaw Chemical Co.
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Norton Co.

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Sodium Nitrite
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Norton Co.
Thomas Alabama Kaolin Co.

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Green, A. P., Fire Brick Co.
Thomas Alabama Kaolin Co.

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Harshaw Chemical Co.
The Hommel, O., Co., Inc.
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Titanium Oxide
Ceramic Color & Chemical Mfg. Co.
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Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

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Louthan Mfg. Co.
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Norton Co.

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Denver Fire Clay Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.

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Harshaw Chemical Co.
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Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
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Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Whiting
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Winding Drums
Lancaster Iron Works, Inc.

Zinc Oxide
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
The Vitro Mfg. Co.

Zircon
Edgar Plastic Kaolin Co.
Foote Mineral Co.
The Hommel, O., Co., Inc.

Zirconia
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Metal & Thermit Corp.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

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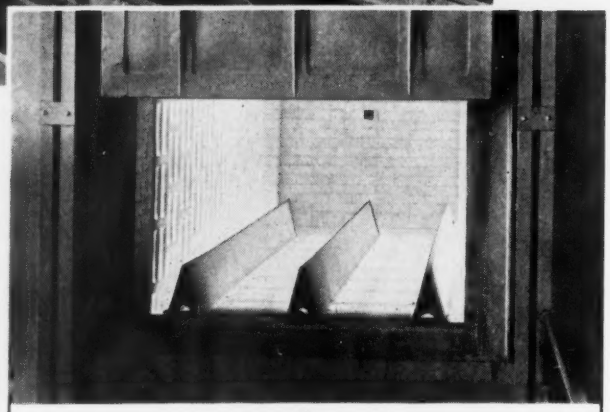

● The muffle is of "Alfrax," the Aluminum Oxide Refractory by Carborundum.
The recuperator is equipped with tubes of "Carbofrax," the Carborundum Brand Silicon Carbide Refractory.
The furnace is by Whipple Furnace Company of Chicago.
The installation is in the plant of a mid-west company and the work is enameling steel stove parts.
Records on this job show that the extremely thin plate "Alfrax" muffle provides unusually rapid and uniform heat conductivity, thus assuring a marked fuel economy—plus a chemical stability which makes certain long, economical muffle life.
The recuperator equipped with "Carbofrax" tubes furnishes air for drying, thus eliminating a heavy fuel bill for drying ware.
And to top it all off, the furnace performance is at such high efficiency as to produce an extremely high grade of enameled ware—and more of it.
May we suggest that Carborundum Engineering Service can help you to equally productive results?

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REG. U. S. PAT. OFF.

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Carborundum, Carbofrax and Alfrax are registered trade-marks of and indicate manufacture by The Carborundum Company

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Cronin China Co., Minerva, Ohio
Crooksville China Co., Crooksville, Ohio
Crossley Machine Co., Trenton, N. J.
Crossman Company, South Amboy, N. J.
Crown Potteries Co., Evansville, Ind.

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Du Pont de Nemours, E. I., & Co., R. & H. Chemicals Dept., Wilmington, Del.

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Hanley Company, Summerville, Pa.
Hanovia Chemical & Mfg. Co., Newark, N. J.
Hardinge Company, Inc., York, Pa.
Harshaw Chemical Co., Cleveland, Ohio
Hartford-Empire Co., Hartford, Conn.
Haws Refractories Company, Johnstown, Pa.
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International Smelting & Refining Co., Akron, Ohio
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Iyo Toki Kaisha, Ltd., Kobe, Japan

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Libbey-Owens-Ford Glass Co., Toledo, Ohio
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New Jersey Pulverizing Co., New York, N. Y.
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Nippon Toki Kaisha, Ltd., Nagoya, Japan
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Norton Company, Worcester, Mass.

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Ohio Insulator Company Div., Ohio Brass Co., Barberton, Ohio
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Owens-Illinois Pacific Coast Co., San Francisco, Calif.

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Standard Sanitary Mfg. Co., Louisville, Ky.
Star Porcelain Co., Trenton, N. J.
Stark Brick Co., Canton, Ohio
Stauffer Chemical Co., Inc., New York, N. Y.
Steele, J. C., & Sons, Statesville, N. C.
Sterling Grinding Wheel Co., Tiffin, Ohio
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Summitville Face Brick Co., Summitville, Ohio
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Surface Combustion Corp., Toledo, Ohio
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Universal Clay Products Co., Sandusky, Ohio
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NEWPORT, KY.

December 1, 1940

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Comfortable Sanitary Pottery Mfg. Co.
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Dear Pete:

These are the times when things are changing rapidly. Running a business this Fall has been just as fast and furious a game as trying to stop Tom Harmon or break through the Minnesota line. Through it all I believe that more and more we appreciate the character of the men that we mingle with and depend on.

Clays too have character, both inherent and built into them by the organization that mines and controls their quality and uniformity.

We sincerely hope that the character of the SPINKS CLAYS that you and our other good friends have purchased from us during 1940 have eased your worries and helped you to make a profit.

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Dick Carothers

General Manager
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